

CONDUCT AND THE WEATHER

AN INDUCTIVE STUDY
OF THE
MENTAL EFFECTS OF DEFINITE METEOROLOGICAL
CONDITIONS

BY

EDWIN GRANT DEXTER, A.M.

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY
IN THE
FACULTY OF PHILOSOPHY
COLUMBIA UNIVERSITY

NEW YORK
MAY, 1899

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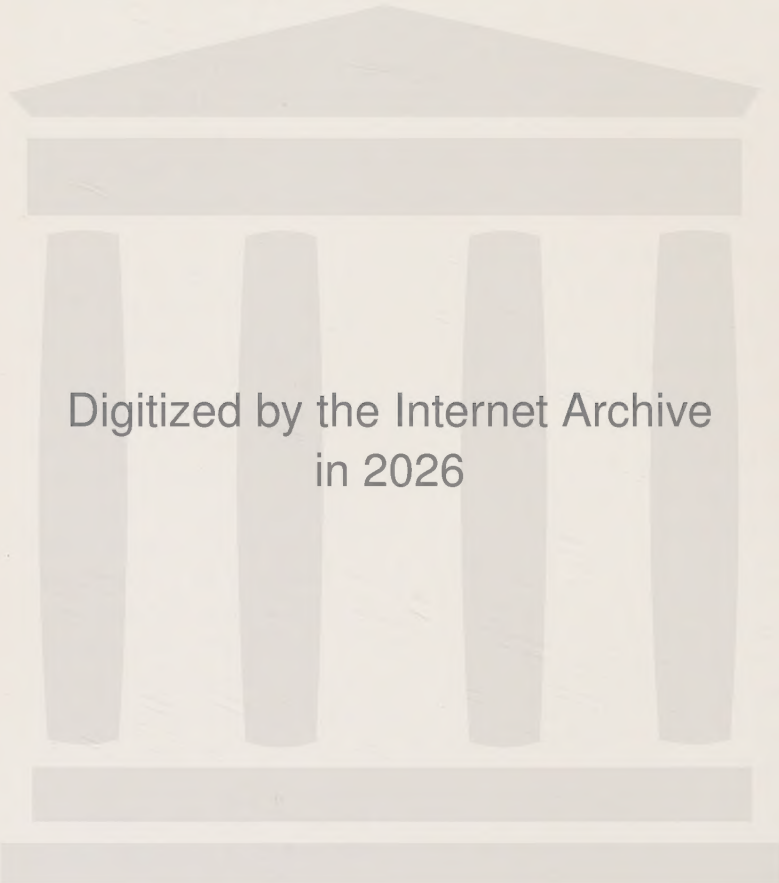
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PREFATORY NOTE.

This paper, in its present form, comprises little more than half the material actually prepared for publication. At its final compilation the volume was such as plainly to exceed the proper bounds of a work of this character, and a large part was left out, with the intention of publishing the whole, with important additions, in book form at some future time. In the reducing process the introductory chapter was cut in two, those specifically treating each of the classes of data except that of the school children omitted, and the chapter in conclusion much condensed.

I wish here to express my gratitude to the many, in all parts of the country, who have so promptly and willingly lent their aid to the work by answering and discussing the questionnaire; also to Superintendent Aaron Gove, of the East Denver School, the Misses Jones and Adams, former pupils of mine, now teachers in those schools, Superintendent F. H. Brandenburgh, of the Denver Station of the U. S. Weather Bureau, and Chief Howe, of the Denver Detective Service, for material aid in making the studies of the Colorado climates. For help in the prosecution of the study in New York City, I am indebted to Superintendent Jasper, of the Borough of Manhattan Public Schools, the Principals of Public Schools Nos. 10 and 93, the Superintendents of the various Corrective Institutions for the City of New York, officials at the Central Police Station and Department of Public Health, and to Superintendent E. H. Emery, of the U. S. Weather Bureau.

To my wife, also, without whose help the immense labor of tabulation could hardly have been completed, I am especially indebted.



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SECTION I.

INTRODUCTION.

The modern science of Meteorology, emerging from the mist and darkness of ignorant guess and surmise, has left its path strewn with many a shattered idol. Jupiter Tonans, the Thunderer, Pluvius, the Rain-maker, and a hundred other weather-gods were toppled from their lofty pedestals ages ago, while St. Swithin and his twoscore of saintly colleagues, whose days dominated the weather for the rest of the year, have been quite as surely if more recently dethroned by the delicate instruments and skillful calculations of the modern weather-man.

It is interesting to turn the gaze backward and view in the light of modern scientific research the fallacies that have been corrected and the superstitions that have been lived down. In the centuries that have gone, each event was a portent; Nature's moods were not interpreted in terms of cause and effect. As a consequence, the weather prophets were likely to forecast that which was most wished for, and to lay down as a general, if not infallible law, that which was a mere coincidence of totally independent events.

What the effects of one meteorological condition may be upon another we care little, and we must, at any rate, leave their study to the meteorologist. The effects, however, of those conditions upon members of the animal kingdom, and especially upon man, are of great interest, though not as a means of weather prognostication. In this modern day, when man is being recognized more and more as a creature of his environment, a sequence of personalities, each one of which varies from all the others as the conditions of that environment vary, it has seemed strange that, of external conditions, the weather has received so little scientific attention. Although there is considerable literature bearing directly or indirectly upon the subject, the bulk of it is principally interesting to the physician,

treating, as it does, of the effects of weather upon bodily health and disease. Although the health and strength of the body are but other terms for expressing its physical condition, the health and strength of the mind are as directly traceable to the same physical conditions of the body, and it seems probable that mental states, especially emotional states, are affected even more noticeably by weather conditions than are the underlying physiological ones. Of course, the former are affected only through the medium of the latter; but the condition of mind may be considered the dial which indicates on a large scale certain minute changes physiological, and, although in our study the use of terms might imply a direct effect of weather upon mind, an intermediate element, the body, is of course always presupposed.

That there is a relation between weather and mental states, which seems hardly other than cause and effect, has seemed evident to many. A writer¹ in one of the British magazines some years ago very aptly said, "There are many persons who are simply victims of the weather. Atmospheric influences play upon them as the wind plays upon the strings of an æolian harp, with the difference that the latter never utter discords in reply. A leaden sky weighs upon them with a crushing weight, and suggests all manner of unpleasant anticipation. Then the gloomy side of life comes out. The bitter sayings of friends are remembered. The old groundwork of forgotten quarrels is remembered; uneasy questions arise with regard to the future. One gets tired of life. A sort of indefinite dread is the general mental influence, a faint continuation of the superstitious fancies which mark the childhood of nations and men."

Who has not at times felt this influence? In all the vigor of perfect health it may hardly be recognized; but when the vital forces are depleted by the exhausting effects of a long nervous or physical strain, the influence of this phase of cosmical environment is sure to make itself known. Then come those days when everything is sure to go wrong. How inconsiderate are our friends when the east wind blows and the skies are heavy! If we are teachers, how provoking the pupils sud

¹ See *Once a Week*, Vol. xix.

denly become ! How dangerously doubtful seems to-day the venture which yesterday, in the bright sunlight, seemed certain of success !

Definite statements of teachers, prison wardens and superintendents of the insane with regard to these effects will be considered in later chapters of this study ; but literature is full of citations which lead us to believe that those who have ‘felt most’ this great world’s pulsations have been perceptibly affected by its temperature. Charles Lamb said, “That nothing less than a sweltering August sky could meet his craving.” At such a time, he remarked, he felt himself immortal, “as strong again, as valiant again, as wise again, and a great deal taller.”

The poet Moore rejoiced like a song-bird in the sunlight :

“ No joy like this
To sit in sunshine calm and sweet.
It were a world too exquisite
For man to leave it for the gloom,
The deep, cold shadow of the tomb.”

Byron, too, shows that a bright day had an extraordinary and apparently unusual effect upon him.

“I am always more religious,” he said, “on a sunshiny day, as if there were some association between the internal approach to greater light and purity and the kindling of this dark-lantern of our external existence.”

He could “bear cold no better than an antelope, and never yet found a sun quite done to his taste.”

Shelley loved the intensest ardor of the sun, and wrote many of his best things on the roof of his house near Leghorn, unscreened from its rays. Rousseau, like him, used to bare his head to the sun. As soon as the days began to turn, the summer for him was at an end : his imagination at once brought winter.

Southey, during one of his temporary visits, in England, after a long sojourn in Italy, very forcibly expresses himself in a letter to a friend : “I have lived too long abroad to be contented in England. I miss the sun in heaven, having been upon a short allowance of sunbeams for the last ten days, and if the nervous fluid be the galvanic fluid, and the galvanic fluid the

electric fluid, and the electric fluid condensed light, zounds ! what an effect must these vile, dark, rainy clouds have upon a poor nervous fellow like me, whose brain has been in a state of high illumination for the last fifteen months."

Shakespeare himself was keenly observant of the effects of weather. One of the most striking examples of this is in 'Romeo and Juliet.' The fatal brawl in which Tybalt is slain is precipitated by the effect of the temperature upon the principal actors. Benvolio realized that possibility, and, in an attempt to restrain his lively companion, said,

"I pray thee, good Mercutio, let's retire;
The day is hot, the Capulets abroad,
And, if we meet, we shall not 'scape a brawl,
For now, these hot days, is the mad blood stirring."

But his warning was disregarded. As a result, when the Montagues and the Capulets met, they fought: Mercutio lost his life; Romeo was banished for slaying Tybalt; Juliet was forced to take the potion to avoid a hateful marriage with Paris during her lover's absence, and was discovered, apparently dead, by Romeo, who killed himself; while Juliet, by awakening, completed the tragedy, 'falling dead on the body of her lover:' terrible results of this one hot day.

In this case, as in many others, subsequent investigation has tended to corroborate the wonderful power of observation of this great master. In the records of the public schools we may feel the pulse of the pupils, in those of the penitentiary we may observe the fluctuations in the temper of the inmates, and in the journals of the police courts find relations, too obvious to be regarded as mere accidents, between the 'mad blood,' and the temperature and other weather conditions when most it was 'stirring.'

SECTION II.

STATEMENT OF THE PROBLEM.

In the following chapters I have attempted, in an inductive manner, to throw some light upon the peculiar effects of weather conditions on mental states. That there are such effects no

one can doubt. Dr. Johnson may treat them with ridicule, and the strong and robust be scarcely sensible of them, but the great majority of us are fully alive to their power. Yet modern science is not satisfied with a mere knowledge of their existence. Generalizations will no longer suffice in answer to its scrutinizing inquiry. Is the cause capable of analyzation into components, each of which may contribute in its peculiar way to the indicated result? To this our answer is, yes. Those states and conditions, mutations and changes in our cosmical environment to which we give the name weather, do not form a unit, but a composite. The various meteorological conditions, ringing in as they do combinations innumerable, are the ever-changing elements of the cause whose relation to human conduct and emotions we are attempting more definitely to define. It is, for the most part, a study of those weather components and their discernible relations to human activities which this paper treats. Yet it may be necessary at the outset to define our use of the term 'cause,' as applied to the weather or its meteorological components. We do not mean a primary, but a secondary factor. In none of its phases, probably, is the weather the inciting cause to action; but under some of its conditions the mind seems better able to withstand an impulse than under others. In this sense only do we mean cause,—that in the varying conditions some are presented in which impulse to action seems more liable than usual to overcome an ordinarily overpowering inhibitory force. Such a condition might be said to be the cause of the action.

The problem carried on is twofold: first, the tabulation and discussion of a questionnaire sent to nearly two hundred teachers, of all grades, from the kindergarten to the high school, superintendents of asylums and reformatories, and wardens of prisons and penitentiaries; second, an inductive study of several hundred thousand data of classes mentioned below, comparing the occurrence of data of the various classes studied, under definite meteorological conditions, with the normal prevalence of those conditions.

The letter sent out with the questionnaire, and the questionnaire itself, are as follows:

COLUMBIA UNIVERSITY, Dec. 15, 1898.

Dear Sir: I am making a study of the possible relations between mental states—as shown by behavior and efficiency—and meteorological conditions, as the basis of a thesis for the Doctorate of Philosophy in this University. In addition to the compilation of a great number of data, I am attempting, by means of the enclosed questionnaire, to get the opinions of those who are in positions to make observations bearing upon the subject. If you are disposed to aid by answering its questions, the kindness would be greatly appreciated. If you have subordinates under your charge to whom you would be willing to distribute these blanks, use enclosed envelope for returning name, address and number of blanks desired, and I will send you a reprint of a paper already published by me on the subject, together with the blanks.

Thanking you in advance for any courtesy I may receive at your hands, I am,

Very respectfully,

EDWIN G. DEXTER,

Fellow in Education.

Date,

Name,

Position,

1. About how many individuals are under your direct observation :

Adult	Male	Female
Youth (15-20)	Male	Female
Children	Male	Female

2. Have you noticed any seeming effect of weather conditions on their deportment?

	Hot.	Cold.	Windy.	Calm.	Stormy.	Muggy.	Cloudy.	Clear.
3. What kind of days seem to affect them for the worse ?								
4. On what kind of days do they seem at their best?								
5. On what kind of days does mental work seem at its best?								
6. At its worst?								
7. If your charges do mechanical work, on what kind of days can they turn out most?								
8. Least?								

Put X in proper space. 'Hot' and 'Cold' mean for the time of year. 'Muggy' means 'sticky' or humid.

Extended remarks bearing upon the subject are very much desired, and may be written on the other side of this blank.

If you have noticed a different magnitude of effect upon men, women, boys or girls, please state it.

In many cases the request for extended remarks bearing upon the problem was complied with, and much valuable material was secured. The questionnaire is fully discussed in the chapter 'Department in the Public Schools,' 'Discipline in the Penitentiary,' and 'Insane,' with which data it particularly deals.

The classes of empirical data studied, together with the number of each and the way in which they were obtained, are as follows :

First.—Registration in certain of the public schools of New York for the years 1895-96, 118,860.

In this and the other classes of data which have to do with the New York schools the primary departments only were studied for three of the largest schools of the city, viz., Public School No. 93, corner of Amsterdam Avenue and 93d Street; Public School No. 43, corner of Amsterdam Avenue and 129th Street, and Public School No. 10, corner of 7th Avenue and 117th Street. The Primary Departments were studied first, with the intention of similarly considering the Boys' and Girls' Grammar Schools separately, for the purpose of making a comparison of the meteorological effects upon pupils of different ages, and especially upon the two sexes at the period of adolescence. Inability to procure the data desired without an immense amount of time devoted to a study of the records makes it impossible to include such a comparison in the present paper.

By the term 'Registration' is meant *expected attendance*. The school registers placed at my disposal through the kindness of Superintendent Jasper, of the New York public schools, show what is termed the 'Permanent Register' and also the 'Temporary Register.' In the former are included the names of all the pupils who have been registered in a given grade for the entire term. In the latter are included only the names of those who are for the day in regular standing in the grade, and expected to be present. The latter were taken as representing this class of data. The figures given indicate the number of pupils who were registered for a single day's attendance in the grades studied. I shall call, in succeeding discussions, the school attendance of a single pupil for a single day, one *pupil-day*.

Second.—Attendance in the same schools for the years 1895–96, 108,020.

The data were obtained from the records already alluded to, and the number indicates the number of pupil-days recorded for the exact conditions studied under registration.

Third.—Deportment in the same schools for the years 1895–96, 14,083. Under this head are tabulated for the years studied the number of pupil-days on which marks for imperfect deportments were given. The pupils are marked, when any record for deportment is kept, on a scale of ten, and any mark below ten is considered imperfect. It might at first seem that there would be some value in considering the various marks between ten and the lowest given, as indicating misdemeanors more or less grave; but upon noting certain individual peculiarities in the marking, it was decided that no sufficiently exact criterion could be had, and all not perfect were bunched as imperfect. For instance, some teachers never gave a mark lower than nine, while others invariably indicated imperfect deportment by marks from five to eight. As it cannot readily be supposed that all the pupils under the second teacher were so much worse than any under the first, we must conclude that the differences were in the method of marking, hence an introduction of error if used for exact purposes of comparison.

It might be added, in connection with our statements of data having to do with the New York public schools, that much time was spent in an ineffectual attempt to find records indicating the daily marking in the schools as showing the perfection of class work. No such records are required in the public schools of the city, and in a long series of inquiries not a single teacher was found who had imposed upon herself the task of keeping them. This necessitates the omission from this paper of an interesting phase of the problem, which I hope some time to supply from records of some of the older private institutions, which a diligent search may unearth. The data under classes twelve and thirteen have to do with the effect of meteorological conditions upon the ability to do mental work, and may in part take the place of the class here missing.

Fourth.—Deportment in the public schools of Denver, Colo., for the years 1882–96.

In the study of the public schools of Denver, Colo., made one year previous to the studies in New York City, the records for the fourteen years from 1882 to 1896 were made use of.

No record of daily deportment was kept for any part of that time, the only thing throwing any light upon the question being a record of corporal punishments administered. This record was in the form of notes written in compliance with a requirement of the school board to Superintendent Gove, stating the names of the pupils to which corporal punishment had been administered, and for what. Only those notes were used as data which stated the exact day on which the punishable misdemeanor occurred. It can readily be seen that the exact date of the misdemeanor, and not that of the punishment, is the important thing from our point of view, and many notes had to be discarded because of uncertainty on that point. No attempt was made at any classification of the misdemeanors recorded—so varied were they in their character—nor was the tabulation for the two sexes kept separate.

Fifth.—‘Assault and battery’ for the City of New York for the years 1891–97: Male, 36,627; female, 3,134.

These figures represent the total number of arrests for this crime for those years. They were taken from the records in the wonderfully complete archives of the Police Department of the city. The records for the two sexes were considered separately for purposes of comparison.

Sixth.—Discipline in the New York City Penitentiary for the years 1891–97, 3,981.

The record of dark-room punishments was made use of, it being the only record of deportment permanently kept at this institution. Each man’s chance for commutation of sentence depends upon the freedom of his record from bad marks, and by looking over the individual’s records the data were collected. Care was also taken to make certain that the misdemeanor occurred upon the same day as the recorded punishment.

Seventh.—Arrests for insanity for the city of New York for the years 1891–97: Male, 2,467; female, 1,097. These data were taken from the records at the Central Police Station, and represent the entire number of each sex who were arrested upon

the streets by the police of the city, or were taken from their homes, mentally unbalanced. In most cases they were initial attacks of insanity or, at any rate, the beginning of a recurrent period.

I have visited most of the asylums in the vicinity of New York City in the hope that I might secure some record of discipline or restraint throwing light upon the daily deportment of the inmates, but as yet unsuccessfully. It may be that some future search will be productive of more results and that this phase of the problem may be completed.

Eighth.—Deaths for the city of New York for the years 1886-87, 74,793.

This includes deaths from all causes. The data were taken from the books of the Department of Public Health. The years 1886-87 were used, not that they were any more interesting than other years, but because they were the last for which records were kept in such a way that the exact date of death could be determined without some doubt. Beginning with 1888 the record of issuance of burial permits was the only one kept, and as these were sometimes issued on the day of death, but just as frequently on some following day, these latter records would not have been sufficiently exact for our purpose.

Ninth.—Suicides for the city of New York for the years 1886-87, 706.

These data were collected from two sources, viz., the records of the Department of Public Health and those of the Police Department. The record of successful suicides came from the former source, and are included in the death records; but, since for our purposes an unsuccessful attempt was as valid a datum as the successful, indicating, as it does, suicidal intent, they were included in this study. The police record was the source of our information on this subject, since suicide is considered a felony.

Tenth.—Suicides for the city of Denver, Colorado, for the years 1884-97, 260.

These data were taken from the voluminous scrap-books of newspaper clippings kept by the chief of the detective force of Denver. The city keeps no official register of crime, but the officer mentioned has kept a most complete one, clipped from

the columns of the daily papers, which, through his kindness, was placed at my disposal. The data include both suicides and unsuccessful attempts.

Eleventh.—Murders for the city of Denver, Colo., for the years 1884-96, 184.

These data were taken from exactly the same source as the preceding. A record for assaults, such as is made use of in the study for New York City, would have given us many more data of a class indicative of an emotional state analogous, perhaps, to the homicidal; but it seemed probable that the newspaper record was not complete for this class of crimes, so the record of murder was taken as being more trustworthy and exact.

Twelfth.—Clerical errors discovered in the records of certain of the national banks of the city of New York for the years 1896-97, 3,698.

These data were taken from books known as 'Correction of Errors,' kindly loaned by some of the largest national banks in the city, among them, in fact, the largest bank in the country. These books show the data and the magnitude of all errors made by the employees of the bank, together with the date of their discovery and correction. The date of occurrence was, of course, the important item for our study.

Thirteenth.—Maximum strength tests taken in the Gymnasium, Columbia University, 3,000.

I had hoped to make a somewhat exhaustive study of the effects of meteorological conditions upon the ability to do mechanical work, but was unsuccessful in my attempt to secure the data. Nearly all of the large manufactories of pearl buttons, many of the extensive printing establishments and several cigar factories were visited, in the hope of finding some record of the daily productions by individuals, but none was found sufficiently exact to use as the basis of a study.

Fourteenth.—A study in discrimination carried on in the Psychological Laboratory of Columbia University, 50.

The empirical study of this paper, as was stated at the beginning of this chapter, is made up of a comparison between the occurrence of data under definite meteorological conditions and the prevalence of those conditions. Incidentally, also, is

shown the distribution of the data for the months of the year, and in some cases for the days of the week.

Since all the conclusions of the paper are based upon what I have called 'expectancy,' and any interpretation of the chart presupposes a full understanding of this term, I shall now, at some length, explain its computation and application.

The first process in its construction was carried on at the New York office of the U. S. Weather Bureau (Denver Office for the Denver study). There, in a specially ruled blank-book, were copied the mean *Barometer, Temperature, and Humidity, the Total Movement of the Wind, the Character of the Day, and Precipitation* for every day of all the years for which any of the data of the studies were collected. For New York these years were 1886-87 and 1891-97, inclusive, besides the limited periods in the years 1898 and 1899 made use of in studying the classes of data already designated as XIII. and XIV.

For Denver the years so studied were those from 1883 to 1896 inclusive. Separate 'expectancy curves' were constructed, by the method I am about to explain, for the period 1886-87, the period 1891-97, the school months of the calendar year 1895-96 and for Denver.

Since these curves were all constructed in the same manner, a description of the process for one will answer for all the others, so I will explain those only for the 1891-97 period.

First.—The expectancy curve for temperature.

By a process of tabulation which was practically but a simplified method of counting, it was ascertained that of the 2,557 days of the seven years considered, 2 had been recorded as having a mean temperature between 0° and 5° Fahr.; 3 between 5° and 10° ; 21 between 10° and 15° ; 28 between 15° and 20° ; 80 between 20° and 25° ; 142 between 25° and 30° ; 203 between 30° and 35° , and so on, until all the 2,557 days were thus accounted for; in some one of the groups of 5° temperature between zero, the lower limit, and 95° , the upper limit.

It would have been possible in a similar manner to count the number of days for each single degree; but a curve based upon such a complicated series would be almost unintelligible; so

definite meteorological groups have been chosen for each condition, as being better for our purpose than the single unit of measure.

Having thus counted the number of days occurring in each one of the temperature groups of 5° , the next process is to turn these numbers into percentages of the whole number of days, and we find that one-tenth per cent. of the days for the seven years had a mean temperature between 0° and 5° ; .2% between 5° and 10° ; .8% between 10° and 15° ; 1.1% between 15° and 20° ; 3.1% between 20° and 25° ; 5.5% between 25° and 30° , and so on. These figures represent the normal prevalence of the temperatures represented by each of the groups, and are given in full in the table of temperatures (page 85) under the heading "Normal."

Now, it can be readily seen that this represents the percentage of data of any class which the law of numerical probability would lead one to expect under that condition, *if the temperature exerted no influence*. For instance, if 5.5% of the days for the seven years had a mean temperature somewhere between 25° and 30° , the law of probability would lead us to expect that same percentage (5.5) of the entire number of murders or suicides or deaths occurring in that period to have occurred under that temperature group, *provided the temperature itself had no effect*.

To illustrate: One-seventh ($\frac{1}{7}$) of all the days of the year are Mondays, $\frac{1}{7}$ Tuesdays, $\frac{1}{7}$ Wednesdays, and so on through the week. Now since one-seventh equals 14.3%, 14.3% of the days of a year, or any number of years, are Mondays, 14.3% Tuesdays, and the same for the other five days. Since this is so, the law of numerical probability would lead us to expect that same per cent. (14.3) of all the murders or suicides or deaths for a series of years to occur on each of the days of the week, provided there was no condition, social or industrial, to affect their distribution. Whatever variation might be found to exist must be ascribed to some constant force affecting the conditions.

On the temperature table, then, as on all the tables shown, the line near the top marked 'Normal' represents the normal

occurrence of the condition indicated in the top line, and also *the expected occurrence for each class of data.*

For the barometer expectancy, one-tenth ($\frac{1}{10}$) in. variation in the heights of the mercury column was taken as a unit of difference; for humidity, five-hundredths ($\frac{5}{100}$); and for wind, a difference of 50 miles in the total movement for the day. All these percentages may be found in the tables given (pp. 83-88) under the heading 'Normal,' and also plotted to a scale upon the charts under the heading 'Normal Prevalence.'

As has been stated, a special 'expectancy curve' was made use of for the year 1886-87 and for the school years. The necessity for so doing was this: Although the 'expectancy curve' for the seven years from 1891-97 inclusive may be considered a normal curve for all time, it could hardly be referred with exactness to isolated years without the introduction of considerable error, due to the variation of those years from the true normal, hence the necessity of extra labor in the preparation, in exactly the way outlined, of a special curve for these years.

A separate curve for the school year is even more necessary, since so large a portion of the calendar year, and that at one of the extremes of temperature, is left out. Neither of these special expectancy curves is shown upon the tables or charts, though they have been made use of in plotting all the curves indicating conditions for death, suicide and the school problem.

Having explained the construction of the 'expectancy curve,' it now remains to show its application. Opposite the meteorological conditions for each day, as they were copied in the blank-book already referred to, were placed, in separate columns, the number of data for each class for that day,—that is, one column for each of the data relating to the public schools, one each for male and female assaults, one for discipline in the penitentiary, one each for male and female insane, and so on for all the classes studied.

Since all were treated alike in constructing what I have called the 'occurrence curve,' that for male assault only, in its relation to the expectancy curve for temperature, already discussed, will be considered. The sum of the data for this

class of assaults for the 2,557 days of the years 1891-97 inclusive was 36,627. By the process of tabulation made use of in constructing the expectancy curve, it was found that 50 of that number occurred on days when the temperature was between 0° and 5° Fahrenheit; 53 between 5° and 10° ; 253 between 10° and 15° ; 288 between 15° and 20° ; and so on for each group of 5 degrees up to the upper limit of daily mean. Turning these numbers into percentages of the whole, as was done in the previous discussion, we have .1% for the temperature group 0° to 5° ; .1% between 5° and 10° ; .7% between 10° and 15° ; .8% between 15° and 20° ; as shown by the line of percentages in the temperature table (page 85) indicated by the heading 'Male Assault' in the left-hand column of this table. The curve itself is not shown upon any of the charts. Now, we have already computed and shown in the 'expectancy curve' the percentages which the law of numerical probability, applied to each of the temperature groups, would lead one to expect. A comparison of these percentages of occurrence with those of expectancy would indicate whether there was an excess or a deficiency for any of the groups. This is shown numerically in the second line of figures under 'Male Assault,' in the temperature table, and graphically upon the temperature chart, by the curve marked 'Male Assault.' To explain more fully, making use of the figures for the temperature groups from 0° to 15° .

The line marked 'Normal' on the temperature table shows that for the groups 0° to 5° we have an expectancy of .1%.

The line marked 'Male Assaults,' that there was an occurrence of .1%; the next line below, under 'Male Assault,' that there was neither excess nor deficiency, and is marked ± 0 . Upon the temperature chart (Fig. 10) the fact is indicated by the curve marked 'Male Assault,' starting in this group (see left column) from the heavy horizontal line to which the relation between 'expectancy' and occurrence is referred in all the charts. From this table it will be seen that for the temperature group 5° to 10° , the expectancy was .2%, and the occurrence .1%. But .1% is but one-half of .2%, or 50% of .2%, or 50% less than .2%, and we have its relation to the expectancy indi-

cated as -50% . This fact is shown on the temperature chart by the curve in this group being, as it is, two and one-half of the squares which represent 20% below the heavy line. For the group 10° to 15° the expectancy is $.8\%$, and the occurrence $.7\%$. But 7 is 1, or $\frac{1}{8}$ of 8, less than 8, or 12.5% ($= \frac{1}{8}$) of 8 less than 8, which fact is indicated upon both the table and the chart. For the next group the expectancy is 1.1% and the occurrence $.8\%$. By the same computation it will be seen that $.8\%$ is $.27\%$ of 1.1% less than 1.1% , which is also indicated in both places.

This is the method of computation made use of in all the curves except those marked 'Normal Prevalence' (which is, in fact, the expectancy curve), and the 'Attendance' curve upon all the charts except those for data classed as XIII. and XIV.

In brief, when a curve is above the heavy horizontal line it indicates an excess of data to an amount represented by its distance above the horizontal or datum line; when below, a deficiency of the magnitude indicated by its distance below. In both cases the temperature group is shown by the figures at the top of the chart. Although the curves show with empirical exactness the relation between the *expected* number of occurrences and the actual number for any group of meteorological conditions, there are some few facts which might well be borne in mind in regard to them:

First.—They mean more and perhaps are more valid near the center of the curve than at the extremes, for the reason that near the center they are based upon more data and are, therefore, less liable to be affected by accidents. The normal 'expectancy curve' upon each plate shows the percentage of occurrences expected for each meteorological group, and from it the relative values of each of the other curves for those groups may be judged.

Second.—Each meteorological condition has to be studied and the curves constructed as if none of the other conditions were in any way effective.

Unless two or more of the conditions tended to vary in the same way, this fact would have no effect upon the curves, as otherwise, in the great number of days studied, the influence of

one upon another would tend to negative the effect. If, however, two conditions generally accompany one another, there would be a possibility that effects indicated by the curve of one condition were contributed to by the other, without that fact being in any way shown.

Third.—The excesses and deficiencies indicated by any curve need not be and probably never are equal. Although the sum of all the percentages of the ‘Normal Prevalence Curve’ and also the ‘Occurrence Curve’ (not shown), upon which the curves for each class of data are based, is 100, it is not so for the curves plotted, because the latter are based upon many more data in some parts than in others. To give a concrete example: in a certain meteorological group 1% of all the data considered might be expected and 2% occur,—that is, 1% more, or twice as many,—but the plotted curve would show 100% excess. In another meteorological condition 10% of all the data might be expected and 9% occur (the same actual number less), while the plotted curve would indicate a deficiency of but 10%. From this illustration it may be seen that there can be no constant relation between the indicated excesses and deficiencies of any curve.

Fourth.—By making use of meteorological groups rather than smaller units of measure for each condition, some of the real effects of those conditions may not be indicated by the curves. It would, however, be utterly impracticable to work out the expectancy and occurrence for each degree of temperature or for each hundredth of an inch of the barometer, and I am inclined to think that the loss for grouping is very slight. Certainly there is no positive error introduced by so doing.

SECTION III.

THE METEOROLOGICAL CONDITIONS.

Since we have considered the effects of weather as but the resultant of the combined effects of its ever-varying components, it is necessary that those components be defined and a description given of the process of their measurement, as carried on by the United States Weather Bureau.

Incidentally, too, we mention the recognized influence of each meteorological condition upon climate, in its effects upon racial traits.

TEMPERATURE.—Man surpasses all his fellows in the animal kingdom in his ability to live in different degrees of temperature, the extreme range of the thermometer for all parts of his habitat being nearly 200 degrees Fahrenheit. It is even probable that a single individual might experience both of these extremes for a brief period without disastrous results. In their effects upon the race, however, varying temperatures have been recognized by every student of climatology. Inhabitants of hot climates are apt to be listless, uninventive, apathetic and improvident. An equable high temperature, especially if moist, weakens body and mind. No long-established lowland tropical people is a conquering race in the broadest sense of the word. For the inhabitants of the higher altitudes, even under the tropical sun, this may not be true; for as we ascend the temperature lessens about 1 degree every 270 feet on an average, and even at the equator we may have a temperate climate.

The most favorable temperature for health that carries with it an aggressive energy which is felt, and which has led the world-march of civilization, is about 55 degrees to 70 degrees, on an average; and this is found in the temperate zones. From there have come the brawn and brain of martial conquest and intellectual attainment. The dominant peoples are shown between the latitudes of 25 degrees and 55 degrees. Farther north the available vital energy seems so largely expended in furnishing mere body heat and stimulus for the necessary physiological functions that there is little left for use in those activities which make leaders.

The question as to the ability of races to thrive under conditions of temperature other than those of their ancestors is one which has received considerable attention. It has long been held that the tropics could never become a field of conquest for the nations of the temperate zones, since the climate rendered occupation by them impossible. Notwithstanding the fact that distinguished observers maintain this,¹ experience seems to

¹ Pearson, Wiener, Orton, Curtis.

demonstrate that acclimatization depends very largely upon a rigid observance of sanitary and hygienic rules, and many places which were once considered fatal to the white man are being proved comparatively healthful. When we consider that they have lost their bad name solely by an exercise of local and personal hygiene, we must not despair of the power of man to reduce the unhealthfulness of even large areas in tropical climates.

The apparatus used by the Weather Bureau for measuring the exact temperature at its various stations are the thermograph and the maximum and minimum thermometers. The former gives a continuous record of the temperature; the latter two show respectively the highest and the lowest for each twenty-four hours. The temperature readings made use of in this study (except for classes of data XIII. and XIV.) are the average of the maximum and minimum for each day. This is found to be practically the average of all the temperatures for that time—that is, of the thermograph readings.

BAROMETER.—At the sea-level, or near it, the mean barometer readings for the year are practically the same the world over. Any study, then, of the effects of climate as indicated by prevailing barometric conditions must be largely one of altitude. At the level of the sea the weight of the atmosphere above is equal to the weight of a column of mercury 76 mm. or 29.98 inches high, this being the normal height of the barometer at that level. As we go to higher altitudes, we climb through some of the atmosphere, leaving it at levels below us. This fact is shown by lessening of the height of the mercury column as compared with lower barometric readings. For the lower regions of the atmosphere (three miles or so) the mercury column falls about one inch for each 1,000 feet of ascent. The variations of the barometer at a given location are due to atmospheric conditions, such as moisture or an upward or downward direction of wind currents. We are not, however, concerned with such variations in this chapter.

The general effect of high altitudes is undoubtedly an invigorating one, though liable to affect disastrously the action of the heart and the nervous mechanism. The ability of a healthy

man suddenly to transplant himself to altitudes at which the pressure of the atmosphere is reduced one-third or even more, without effect, seems wonderful. I have myself spent some weeks in succession at an altitude of over two miles, and on several occasions spent the night upon the summit of Pike's Peak (14,147 ft.), without noticing any effect other than a slight quickening of pulse and respiration. Prolonged residence, however, at any altitude above one mile seems, at least in Colorado, to prove cumulative in its effect upon the nervous system, inducing in most cases a neurotic condition that is only relieved by a temporary residence in a lower altitude. These facts will be alluded to in a discussion of the Denver curves.

Dr. Marcet says,¹ "The effect of altitude and cold combined is to increase the amount of carbon dioxide expired. Less air is expired at high altitudes. It appears that the blood more readily acquires oxygen there than at low levels."

Increased expansion of the chest and action of the heart adds to the strength and vigor, and mountain races are generally fine in build. If, too, we are to judge by the histories of the Swiss people and of the Spartans, or even the mountain Indian tribes of our own country, compared with those of the plains, we must concede that boldness in the face of danger and a love of liberty are in some way closely associated with life in the higher altitudes.

For studying the pressure of the atmosphere, the stations of the Weather Bureau are equipped with self-registering aneroid barographs and mercurial barometers. Readings from both are corrected for the altitudes of the station, and the latter for variations in temperature. The barometric data used in this study (except for classes XIII., XIV.) are the *means* for the maximum and minimum of each day.

HUMIDITY.—Great humidities are preëminently characteristic of the climates of certain localities, and very low ones of others, and the effects of the two conditions upon the inhabitants have been the subject of considerable study. The greater part of it has been, however, to discover their effect upon various prevailing diseases, though not without bringing out incidentally

¹ Proceedings of the Royal Society.

the general influence upon race type. From the standpoint of health, dry air is almost universally favorable to human life. This may be due partly to the fact that the germs of contagious diseases do not there find the culture-media for propagation which the moist surfaces of rocks and foliage in a humid atmosphere present, although there is undoubtedly a direct organic effect as well. Excessive heat together with high humidity forms a most deadly combination for one not acclimated to it, as the mortality on the west coast of Africa testifies; while in some localities—as, for instance, western Ireland, the lake regions of England, and the extreme northwestern coast of our own country—much moisture from a great rainfall without excessive heat is not particularly unhealthful. In its effect upon the emotional and intellectual characteristics of a race, it is hard to consider humidity apart from the other weather conditions which accompany its peculiarities.

A region of high humidity must be one of much rainfall, fog and many cloudy days; while one of low humidity, in all probability, lacks these as prevailing conditions. As they are all considered under other headings of this section, and humidity has incidentally been touched upon in the previous topic, we shall not attempt it here.

The determination of humidity, or relative humidity, as it is called by the Weather Bureau, is accomplished by means of two thermometers, the so-called dry-bulb and the wet-bulb.

The first is the ordinary thermometer, by which the temperature is indicated. The second is similar, except that the mercury bulb is surrounded by a cloth which may be saturated with water. When this is done, air is artificially made to pass over the saturated cloth, which causes the water to evaporate rapidly. The heat which is rendered latent by this process comes from the mercury of the thermometer, making it descend in the tube with a rapidity proportional to that of evaporation. In dry air the latter process is much more rapid than in damp air, and by noting the difference of the readings of the dry-bulb and the wet-bulb instruments, and making a simple mathematical computation, the relative humidity is determined. It is read in hundredths, one hundred meaning air saturated with moisture,

and zero, air free from it. The former point is sometimes reached; the latter never. The humidity made use of in this study (except XIII., XIV.) is the *mean* of a morning and an afternoon observation.

WIND.—As an element in climate, the effects of the wind are harder to determine than those of other meteorological conditions. Not that its effects are not great; but that they are occasional, and might perhaps more strictly be regarded as an element of weather than of climate. A study of the chapters that compare the wind effects at Denver with those at New York will convince one that they certainly are not in any way proportional to the velocity of the wind; but with the prevalence of other meteorological conditions, together with the wind; each, seemingly, strengthens the effect of the other. The direct physiological effects of winds of different humidities have been noticed.

Dr. Arthur Mitchell,¹ in a report read before the Meteorological Conferences, speaks of the effects of the east wind prevailing on the coast of England:

“Such winds, blowing over a moist surface, such for instance as that of the human body, tend to reduce the temperature of that surface to the temperature of evaporation, which is much below that of the air itself. In licking up the moisture—that is, causing its evaporation—a large amount of heat is rendered latent. This heat must be taken from something, and, in point of fact, our bodies are, and must be, almost its entire source. A cold and dry wind therefore cools the surface of our bodies, not only by enveloping them in a cool medium and warming itself by conduction at their expense—it does that of course—but, being dry as well as cold, it does it with less activity than though it were moist and cold, damp air being a better conductor than dry air. It is chiefly, however, by the other mode that dry, cold winds abstract heat from our bodies—that is, by using their heat in the conversion of moisture into vapor. The heat so used becomes latent, and is, for the time being, lost. It does not raise the temperature of the air in immediate contact with our bodies. The quantity of heat which our bodies

¹ *Nature*, Vol. 30, p. 355.

lose is probably far from insignificant, and the loss cannot be sustained without involving extensive and important physiological actions, and without influencing the state of health. In feeble and delicate constitutions the resources of nature prove insufficient to meet the demands made upon them, and a condition of disease ensues. It does not seem improbable that prevailing winds of such characters might be considered as elements in climate, which might in the course of time produce even racial changes. Certainly the nurture of disease, especially if the disease prove to any extent mortal, would, in accordance with the laws of heredity, tend toward the introduction of physiological tendencies, which might even have their mental concomitants."

Of occasional winds, some, such as the siroccos of northern Africa, are so baneful as also, it seems, to leave permanent results upon the characteristics of the people. In *The Living Age*¹ there is a description of the peculiar effects of winds sometimes prevalent at Buenos Ayres, South America. Sir Woodbine Parish, upon whose book the extract is based, says:

"To the north of the city lies a very marshy district, while to the southwest lies the great chain of the Andes, separated only by the dry plains of the Pampas, and according as the wind blows from one or the other of these directions the effects are very remarkable. By the time the north wind has reached the city it has become so overcharged with moisture that everything becomes instantly damp. The effects produced in the human body are a general lassitude and relaxation, opening the pores of the skin and inducing great liability to colds, sore throat and all consequences of checked perspiration. This damp wind of La Plata seems to affect the temper and disposition of the inhabitants. The irritability and ill humor it excites in them amount to little less than a temporary derangement of their moral faculties. It is a common thing for men among the better class to shut themselves up in their houses during its continuance, and lay aside all business till it has passed; while among the lower classes it is always remarked that cases of quarreling and bloodshed are more frequent dur-

¹ Vol. 17, p. 1118.

ing the north wind than at any other time. Even murderers are said to lay to it the blame of their foul deeds. No sooner, however, does the southwest wind, blowing from the dry and snowy summits of the Andes, set in, than health and comfort and peace are restored."

Disastrous to good conduct as these winds seem to be, they are hardly worse than some exactly their opposite—both in temperature and moisture—which are occasional visitors to the higher altitudes of Colorado. During the prevalence of such, the humidity is invariably excessively low, and in the dry air there seems to be set up, by the movement of the wind particles and the leaves and grasses set in motion by them, an electrical state which in some undetermined way wreaks havoc with the emotions. Its effect is, however, shown empirically by some of the curves.

The Signal Service makes use of two instruments in studying the wind,—a vane with automatic electrical indicator for showing its direction, and the anemometer for registering the velocity. Both of these are exposed to the unobstructed force of the wind, though connected electrically with the indicators in the office below. Both the instruments register upon a drum revolved by clock-work, and at any time the direction and velocity of the wind can be seen at a glance. The total movement for the days, or the number of miles blown for that period, is used in all our studies except

CHARACTER OF THE DAY.—This condition has no relation to rain or snow-fall; nor is fog indicated directly by any of its conditions. The terms 'Fair,' 'Partly Cloudy' and 'Cloudy,' refer only to the periods of sunshine for each day compared with the whole time from sunrise to sunset. If for eight-tenths or more of the latter period the sun is obscured, the day is characterized as 'Cloudy'; if four-, five-, six- or seven-tenths are obscured, as 'Partly Cloudy'; if less, 'Fair.'

Many opinions have been expressed, both in general literature and in purely scientific writings, as to the racial influence of these characteristics of climate. Italy has always been 'Sunny Italy,' and England 'Gloomy Britain,' and the supposed effects of the two conditions made the excuse for many differing traits of

character. Dickens based many of his tragic climaxes upon his analysis of their influences, and many other writers have made stock of them. Yet, after all, characterization of any race must be based upon definite acts of individual members of that race; and a comparison of races and racial traits should be made only through a comparison of the conduct of their respective peoples. In such an inductive study we fail to corroborate the mass of existing opinion with respect to the effects of a 'sunny clime' or its opposite. It has been stated that "the excessive number of suicides for England is due to its gloomy climate" (Montesquieu); but data show that the number per 100,000 for England is less than that for any other important European country.¹ Vilemais maintains that "nine-tenths of the suicides occur in rainy or cloudy weather." For data in refutation of that statement, in New York City at least, for the period considered, I refer to the curve for suicides in New York, shown upon Fig. 14.

Another interesting fact bearing upon this point is shown on the same chart by the Denver suicide curve; and, although the percentage of fair days is three times greater than in New York City, the suicides run up as much for cloudy days as in the latter climate they run down.

Even at the risk of robbing the section in which suicides are especially discussed, I shall here insert a quotation from a very interesting paper that appeared in *Once a Week* (Vol. 19) without signature (the writer was evidently not a Scotchman):

"The idea that the prevalence of suicide in this country is due to our bad weather is precisely one of those hasty and illogical inferences which are characteristic of the Gallic mind. The constant gloom of bad weather ought to acquaint us so thoroughly with moods of depression that suicide would never occur to us. Look at Scotland, for instance, where suicides are rare. Why are they rare? Simply because a succession of Scotch Sundays has so accustomed the people to prolonged despondency that any sudden misfortune cannot sink their spirits any further. One has only to spend a dozen Sundays in Glasgow or Edinburgh to become inoculated against suicide.

¹ Morselli, Suicide.

So far from November fogs driving people to jump off Waterloo Bridge, they ought to train and educate the mind to bear any calamity. A man who has taught himself to eat prodigious quantities of opium feels scarcely any effect from other forms of intoxication. We can educate our mental susceptibilities as we can our muscles, and the more we educate them the more they will bear."

There are many truths beneath the jocular vein of this quotation, and the writer expressed more fact than perhaps he knew. A constant succession of gloomy days is certainly not conducive to emotional flights; but the sturdy determination and evenness of temperament of the English have without doubt been contributed to by them. The almost constantly sunny climate of Colorado has, I believe, even in the few years which it has been enjoyed by the white man, tended to produce a state of emotional inequilibrium which has shown itself in many ways, and has had its effects upon the political and social history of the region.

The apparatus used by the Weather Bureau for determining the character of the day is known as the 'sunshine recorder.' It consists of a thermometer, with its bulb blackened to increase the absorption of heat from direct sunlight, enclosed in a vacuum tube to prevent as far as possible the direct influence of the temperature of the surrounding air. The piece of apparatus is in such a position as to receive the sun's rays during the entire day. When the direct rays strike the blackened bulb the mercury suddenly rises and closes an electrical circuit, which causes a record to be made upon a revolving drum in the office below. When the sun is obscured the mercury drops and the circuit is broken. The computation in tenths of the possible sunshine hours is made by the weather official.

PRECIPITATION.—There is little to be said upon this condition of climate, in its effect upon race characteristics, which has not been touched upon under the preceding topic. By it is meant a fall of water in some of its physical states.

Regions where precipitation is great are generally less healthful than where the amount is less, though some exceptions to this have already been cited. Attention might here be

called to the fact that the relation between cloudy days and those showing precipitation is not so constant as might at first seem probable. That is, a day on which a shower took place, even though the rain-fall was considerable, would be classed among the fair days, provided the whole period of cloudiness was less than three-tenths of the period from sunrise to sunset. Since, however, there are no climates where days of such a character form a constant element, they need not here be taken into consideration. Undoubtedly thunder-storms induce in many persons emotional states which seem to be productive of excesses in deportment; but we must remember that these excesses are caused by the electrical conditions or by a superstitious fear which cannot be controlled, and we should not attribute them to the precipitation. These are, however, elements of weather, rather than of climate in its broadest sense.

The latest device used by the Weather Bureau for measuring the precipitation consists of a hopper or scale-pan which is so constructed as to tip and empty itself, and at the same time make an electrical indication of the fact in the office below, for each one-hundredth of an inch precipitation. By counting these records upon the revolving drum the officers can tell the exact time, the rapidity and the amount of precipitation for each shower or period of rain.

In our study, a day is considered as having precipitation if the hopper of the instrument has emptied itself once. No consideration is taken of the amount beyond this.

SECTION IV.

THE PUBLIC SCHOOLS.

The phase of the weather problem discussed in this section was, at the beginning of the work, the only one anticipated. The whole study was undertaken from the standpoint of the teacher, with the hope of answering some of the puzzling questions which arise within his mind as to the seeming effects of these conditions on the cosmical environment. As the work proceeded, it broadened more and more, taking in other classes of

data cognate to the subject, until those mentioned in the last section were considered, with the field scarcely entered. The study has become a fascinating one, and though sanguine of the validity—as far as inductive studies may be valid—of certain of the conclusions, it might be well to state what seem to be the exact scope and bearing of the problem.

1st.—It does not seem probable that we are dealing with the *immediate cause* of any of the occurrences studied. In the case of those considered in the present section, we are not supposing that a low condition of barometer and a low humidity were the direct causes of misdemeanor, but that under such conditions an impulse to be refractory, whatever the immediate cause of the impulse may be, could not be as well withstood as under certain other conditions. In other words, the meteorological conditions are the essential causes of certain general physiological or mental states, some of which seem to be fertile fields for the action of immediate causes which are, from the standpoint of this problem, accidental. To be concrete: on a certain morning Johnny could not have what he wanted for breakfast, and went to school with the sulks, with a consequent disastrous effect upon his deportment. Most certainly the disappointment at home had a causal relation to his demerit, and no excuse from the weather is sought. But if we take the record of 200 Johnnies for 600 different days, and find that on certain days more of them are out of sorts than on other days, we look for a constant condition which might be considered in some way the cause. We cannot suppose that bad breakfasts or whippings at home or the disappointments common to child life would bear this constant relation, so look for it elsewhere. Wherever found, it must be considered valid. But it must be some factor which would be a part of the environment of all the children similarly affected. We have sought for it in the varying conditions of weather, with what success is shown by the curves which form the basis of our discussion. Remember, then, that when we say that high temperatures *cause* an excess of suicides or any of the other occurrences studied, we mean it only in this secondary sense. This explanation must serve as an answer to many of the hypothetical explanations of conduct which were

made in answer to the questions we are about to discuss; in fact, would apply to all the abnormal states which were accidental to individuals, whatever their character or immediate cause.

2d.—Although the study discussed in the present chapter is based upon the deportment of children as judged by the teacher, it is not at all certain that the emotional state of the teacher is not an important factor in the result. Indeed, it may be the teacher that we are studying more largely even than the pupil. This has been suggested in many of the notes I have received, and it seems evident, by comparing the curves from the children with those based wholly on the conduct of adults, that the latter are affected even more than the former. But even granting this, we are studying the effect of meteorological conditions upon mental states, and since the present relation of pupil and teacher must remain what it is, our conclusions are valid.

3d.—The effects upon different individuals cannot be supposed to be at all commensurate. There may be many whom weather conditions do not appreciably affect; but in any inductive study we seek general laws, and though they may not be true for any single individual, yet they are valid for them all as a class.

Many of the remarks by teachers in various parts of the country in response to the request at the bottom of the questionnaire (see page 6) are very valuable, and I regret that space does not permit the publication of more of them in full. Of the 200 questionnaires sent out, 86 bearing upon the public school problem were returned filled out in full. Several who did not care to answer definitely the questions given, wrote their general observations in a very helpful manner. The exact number of pupils upon whom the answers to the definite questions were based were as follows:

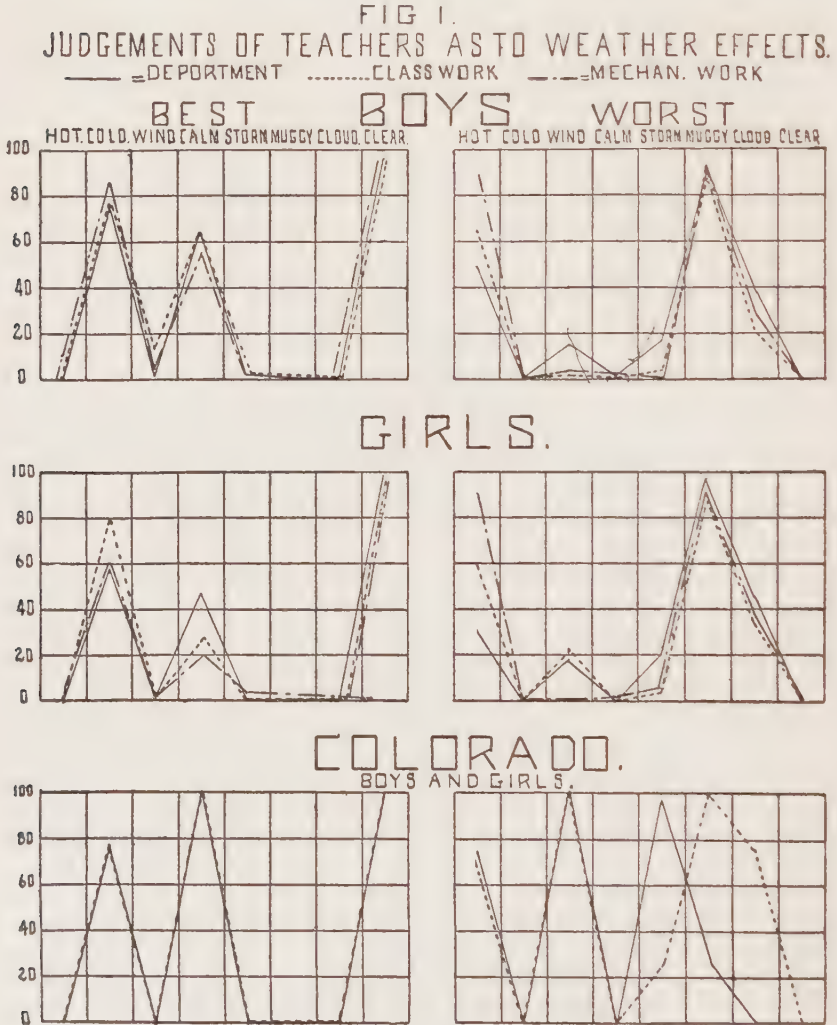
For climates similar to that of New York (Philadelphia, Boston, and the coast cities and towns):

Boys.	4801
Girls	3148
Boys doing mechanical work.....	3300
Girls “ “ 	1500

For Colorado:

Boys and girls.....2218

For the latter climate no estimates were given for the production of mechanical work. In most cases the replies were



from teachers of single grades, giving their judgment based upon observation of a limited number of pupils, though in some

cases city superintendents and principals have sent me their estimates of the weather effects upon larger numbers—in one case (Boston), of 1700. The exact tabulation of all the returns is shown by the curves in Fig. 1. I have there indicated the judgments for the Colorado climate separately from those from other localities.

The curves show the percentages of all the children of each class for whom the judgments indicated were given. To prevent a complication of curves, I have separated those showing the conditions for which deportment or work was at its worst from those under which it was at its best. To interpret one of the curves in full: the entire line in the upper left-hand corner of the chart shows the judgment of conditions under which the deportment of the boys was at its best. None expressed the belief that it was so when the weather was hot. The judgments based upon 75% of the pupils observed were that they were at their best, as far as deportment is concerned, under conditions of cold. One per cent. believed the wind had a salutary effect, 64% calm, 1% stormy, none muggy or cloudy and 96% clear. All the curves may be interpreted in this way, remembering that the curves under the heading 'Worst' indicate the percentages of pupils upon which judgments for that state were based. The fact that the percentages shown by a single curve foot up to more than 100 indicates that more than one condition was mentioned as being that under which the pupil was at his best or worst. In most cases three conditions were thus mentioned, though the papers varied in this respect from one to as many as five.

It must, of course, be recognized that the judgment as to what constitutes a given condition—that is, 'Windy' or 'Muggy,' 'Hot' or 'Cold'—must vary with different individuals; but such conceptions are somewhat constant, and would probably not be the source of any considerable error.

Considering first the curves for climates similar to that of New York, it will be seen that cold, calm and clear days are those on which deportment and work are generally considered to be at their best, with the greatest unanimity with regard to the latter. For 'Worst' condition, muggy days take the lead,

with hot and windy ones in second and third places. Comparing the Department curves for boys with that for girls, we see indicated what is referred to in the notes discussed farther on—that is, that boys are influenced more than girls by the weather conditions, at least by heat, cold and wind. Seventy-five per cent. of the latter (girls) were judged to be at their best on cold days and 64% on calm, to 56% and 46% respectively for the former (boys); while under conditions of heat 50% of the boys were thought to be at their worst to 30% of the girls. A fact worthy of note is the increased bad effect of heat upon the production of mechanical work, over its effect upon deportment or mental work. This would indicate that the increased metabolism of the processes of life under such conditions more largely deplete the reserve for motor output than for mental, and in spite of the irritating effect, emotionally, of the temper, leaves little energy for frolicsomeness.

To summarize in brief these curves, hot, cold, calm, muggy and clear days seem to be the effective ones; cold, calm and clear ones producing a favorable result, and the others the reverse. Windy, stormy and cloudy days are not generally mentioned as having much influence.

In discussing the curves for Colorado, we have but to call attention to a fact which corroborates in a very marked way conclusions arrived at later in this chapter, namely, the marked effect of the wind. All the returns state calmness as an accompaniment of desirable states in the pupil, and wind as the most disastrous. A muggy day is hardly known to Colorado teachers, so we get no corroborative evidence with regard to the problem of humidity treated later.

As shown by the notes received with the data which has been tabulated, I may say that there is a much greater unanimity of belief that the weather has its psychical effects, than of expressed opinion as to what those effects are or the meteorological conditions producing them. The influence upon the teacher of the conditions studied is not infrequently mentioned, and I quote a part of one of the letters bearing upon this point: "Make due allowance for my 'personal equation.' It is impossible for me to say how far my experience is subjective. It

seems to be more marked in this matter than almost any with whom I have discussed it, and I strongly suspect subjective conditions. My experiences when in good and when in poor physical conditions correspond in kind, but are much more intense in the latter case."

The consensus of opinion, both as indicated by the curves and the personal notes, seems to be that girls are much less affected by weather conditions than boys. In eight of the notes the fact was alluded to, while none expressed the opposite opinion. One teacher, a supervising principal of elementary schools in one of the larger eastern cities, says: "The boys are very markedly more susceptible to weather changes than the girls. This apparent result may be due to the generally greater display of effects by the boy, who is under less disciplinary control than the girl."

And another, "Girls are greater adepts, not only at restraining impulses to do mischief, but also in concealing all evidences of it when it is in progress. This may be due to a greater horror on their part of an open reprimand."

It seems to me probable, however, that the matter of reserve and excess of vital energy enters into this problem. The preponderating anabolic tendency of the female, as opposed to the katabolism of the male, may be at the bottom of it.¹ In spite of this expressed belief of a less effect upon girls than boys, a few of the observations by principals, of the influence of the weather upon the teacher, state an opposite effect upon adults of the two sexes.

To quote from the principal of a large city school: "Men, it is true, are depressed on such days" (gloomy days); "but the average man keeps his nerve under proper restraint, which is something which the average woman, from the peculiar mechanism of her nervous machinery, finds it difficult to do. The writer has had during his thirty-four years of professional service the assistance of both sexes, and can say, fearless of contradiction, that men are better able to maintain that patience and quiet demeanor which are necessary in the school-room."

The relation of the two curves for males and females in the study of Assault is corroborative of this opinion.

¹ See *Evolution of Sex*. Geddes and Thompson.

Considering the slight effect of the wind, as indicated by the curves upon the charts, a surprisingly large number of the notes make mention of this condition as having an adverse effect. This was expected from the Colorado returns—in which, indeed, it was universally mentioned as the most potent factor—but not in those from lower altitudes. Since, however, notes were appended to but a small proportion of the questionnaires, the more exact data expressed by the curves are probably more valid. The only other condition of weather which received more than a single mention was snow.

One teacher says, “A cold, snowy day, children restless and noisy.” And another, “A day upon which there is snow seems (in case of boys) to bring all physical activity in them out, and makes them reach a high pitch of physical excitement.” It seems to me possible that this is, in part at least, due to the anticipation of the active sports which snow makes possible. Coasting and snow-balling are always most attractive to the boy, and an impatience to be out of doors, even if the accompanying meteorological conditions were not directly effective, might bring about just the emotional conditions described.

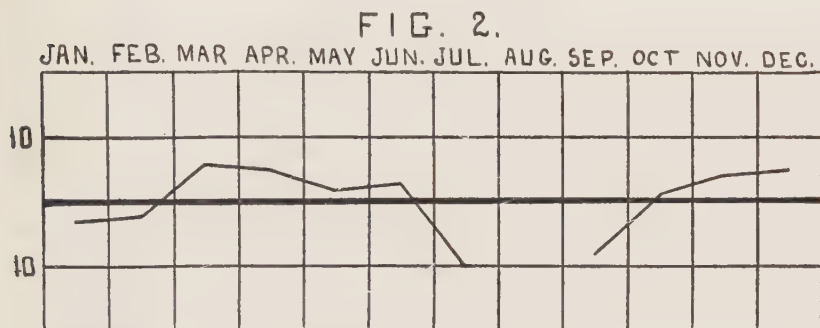
Interesting as are their expressed opinions, from a scientific standpoint they cannot have the weight which the exact data must carry. Both, to be sure, are based upon the judgment of the teacher; but in the tabulation of demerits we have nearly 100,000 immediate judgments, while in a discussion of the opinions expressed in the notes we have but a few, and they liable to all the errors of introspection.

The number of data considered in connection with the study of school children is by far the greatest of any class studied. The labor, too, of securing them was the most difficult, as the records were of such a character that many volumes had to be gone over in order to get the required information.

REGISTRATION.—This term, as made use of here, is fully defined in Section II. so we can proceed immediately to its consideration. Of the entire number of 118,860 days registration, the distribution by months was as follows:—

JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
9723,	8811,	10,063,	10,041,	9963,	9833,	915,		7117,	11,149,	9816,	8455

The difference in numbers is largely due to the varying number of days in the different school months, though not wholly, as is shown by Fig. 2, in which the relation is shown between the *expected* and the actual registration for each month. The *expectancy* for each month was taken as that percentage of the whole number of registrations equivalent to the percentage



of the school days of the year, occurring in the month. This shows that for the schools studied the greatest registration is in the early spring, and again in the fall and winter to the Christmas recess; while it falls during the months of January and February and at the end and the beginning of the school year. Although these studies were made for the large city schools, the conditions shown are practically those observed by every teacher. The sudden drop for May is perhaps not readily accounted for; but the departure for the country and the sea-shore and the late returning in the fall make plain those for July and September. The weather alone is probably accountable for the deficient registration in the winter only.

ATTENDANCE.—Each of the charts of meteorological conditions has an attendance curve, which is not computed as are the others, except normal prevalence, with reference to one of expectancy. By the attendance curve the actual percentages of the pupils absent under all the conditions are indicated. This was done with the thought that this fact might be of more interest to the reader, especially if he be a teacher, than other values, which would be purely relative.

Occurrence.—From this curve it will be seen that there was a large number of absences for January (10.7%), a gradually lessening number through April (7.5%), an increase for May (8.8%), and the maximum for the school year in June.

Beginning in September with a considerable number (9.6%), the minimum for the year is in October (5.4%), and about the same for the next two months as for April and May. There seems to be nothing at all peculiar about the curve; in fact, it shows just about what the experience of a teacher would lead him to expect. When school-work is well under way in the early fall it is, I believe, always more carefully attended to by the pupil than at any other time of the year. Late fall and early winter undoubtedly present more climatic difficulties to attendance than there are in late spring; but as laxness in attendance has not yet developed, the showing is about the same. The bad weather of winter enforces irregularity on the part of many, and this factor, once introduced, tends to stick for the rest of the year, even though excuses because of weather conditions are not so valid. This curve shows for the very end of the year the same irregularity that was indicated by the registration. In the latter case staying at home was officially sanctioned; in the showing for this class of data it was not.

Temperature.—The attendance curves, in their relation to the various meteorological conditions, can be considered as throwing some light upon the effects of those conditions upon the health of the pupils. We cannot suppose that their prevalence, unless it be that of precipitation and perhaps very low temperature, presents any difficulties to school attendance, unless it be through inducing a state of ill health. We cannot suppose a parent would keep a child at home simply because the barometer was low or the humidity high, even if those facts were known. There are many good reasons, to be sure, why a child should be kept at home on a certain day, and it might happen that that day was one of peculiar meteorological conditions; but we have a right to suppose that for the 108,020 pupil-days considered such accidental coincidences would correct each other's effects. If, then, there be any noticeable relations between fluctuations in attendance and in meteorological conditions, the

inference seems valid that the conditions were attended by physical indisposition or a state of low vitality on the part of the child. The temperature curve (Fig. 10) shows that there is a fluctuation in attendance with respect to the conditions indicated. The maximum number of absentees (15%) is shown for the lowest temperature group. As has been suggested, this perhaps indicates no prevailing condition of ill-health, but an unwillingness on the part of the parent to trust the child out of doors in such intense cold. The decrease, however, for temperature above a daily mean of 60° may indicate the relaxing effect of great heat, which is fully recognized and plainly shown by curves for other classes of data. It seems improbable that parents would fear the effects of temperature of the group 65° to 70° upon a healthy child, and thus keep him at home; yet under that condition we have the second largest percentage of absentees. This is an interesting fact when we consider that those unseasonably hot days of spring and fall, which will be shown to have such a marked effect upon the crime of Assault, are of the character indicated by this group. There seems little doubt that they lessened the vitality of the child, and that he was at home being nursed by a fond mamma. The maximum of attendance is indicated by the groups 20° to 25° .

It is very likely that fluctuations in some of the curves may be caused by accidental conditions which cannot, in this study, be discovered, and that only general tendencies in a curve have any value; yet when we note that the most bracing days of our winter climate, those days when the cold is invigorating without being intense, when the streets are dry even though there be snow upon the ground, are of just this character, we are inclined to doubt whether accident be the sole cause of the full school-room.

Barometer.—An inspection of this curve (Fig. 11) discloses the fact that attendance was relatively poor during both extremes of the barometric register, and at its best when the barometer was little above its normal mean. Its fluctuations for the groups between 29.40 and 29.60, so far as I am able to judge, are accidental in their origin. Reference to the chart of Monthly Means (Fig. 8) shows us that the barometer is normally

high for the fall and winter months, and low for those of the rest of the year. There is here no constant relation shown between high and low barometric readings, and the barometer for those months of the year in which attendance was greatest, by which the peculiarities of this curve can be accounted for: and our conclusion must be that the barometric conditions themselves, or the meteorological influences which vary with them, affected the children in such a way as to make it impossible for them to attend. As the barometer is usually low during storms, it may be the latter which were really the effective agents, though showing upon this curve because of the coincidence of conditions. This fact, however, would not effect a decrease during conditions of high barometer, though the fact that such conditions not infrequently exist for a period immediately preceding bad storms might do so. It is a well-known fact that for some little time before storms of unusual violence, sometimes as much as forty-eight hours, a condition exists which strongly affects many people both physiologically and mentally. Persons afflicted with rheumatism and gout, and even those troubled with corns, seem to have intimation through the affected parts of the approaching atmospheric disturbances, and it does not seem improbable that children may in some way be influenced.

The probability seems to be that the very condition of the atmosphere—that is, its relative weight—is not the affecting agent, but other meteorological disturbances which vary with such conditions. The entire variation of the barometer for New York is but little over one inch, while in going from the level of the sea to Denver there is a fall of more than five inches, and to the top of Pike's Peak six more, without any excessive physical or mental abnormalities being evinced: and it does not seem reasonable to suppose that variations of a few tenths of an inch at the former place should be productive of results from the mere difference in the weight or density of the atmosphere.

Humidity.—This curve (Fig. 12) also shows accompanying variation in school attendance. Disregarding slight fluctuations, we have twice the number of absentees when humidities are very low or very high, as for certain intermediate conditions. It is not hard to account for the decrease in attendance for the higher

readings, as they invariably accompany precipitation. Besides this, the de-energizing effects of high humidities accompanied by high temperatures are recognized; although the fact fails to show itself fully, as illustrated by certain curves discussed in the section treating of the death-rate. If, however, the combination has influenced this curve, it would be through conditions of health, indicating that the children were at home suffering from ailments due to the low conditions of vitality induced. The decrease in attendance indicated for the lower humidities is not easily accounted for by any regularly accompanying conditions of the weather which would present physical difficulties to getting out. Storms are rarely known for such conditions. We cannot, however, doubt an adverse effect, for the other curves upon the chart indicate an excess of abnormalities in conduct. This matter will be taken up with more detail in the discussion of the curves for Denver, which show such peculiar results for abnormally low humidities; but there seems little doubt that the uniformly increased electrical potential of dry air is the cause.

It has been demonstrated¹ that for every point upon the surface of the earth there are lines of electrical force radiating outward into space, generally negative in quality at the surface, gradually decreasing in potential and terminating in an electrification of the other quality at some unknown distance in space. It is also a well-known fact to scientists that the potential of these lines of force is much greater when the air is dry than when it is moist; when the humidity is great practically disappearing, but when it is low attaining a great magnitude. The exact physiological effects of this highly electrified state of the atmosphere have not all been determined, but it is certain that it induces a state of nervous tension which any one who has lived in an excessively dry climate cannot have failed to notice. Upon the arid plains of some of our more elevated Western States, Colorado, Wyoming and Utah especially, it is a factor which affects the emotional condition of the people in no small way, and undoubtedly has brought about the excessive rise in the curves for the Denver data, as shown upon this chart. Although the elec-

¹ See Smithsonian Report, 1895, p. 90 et seq.

trification is unusually less for cities than for the country, and is never excessive for climates as humid as that of New York, yet it may have had its effects upon the curve under consideration. If so, it would indicate that the children were at home suffering from nervous conditions which seemed to the parents to warrant missing school for the day.

Wind.—The attendance curve (Fig. 13) for this atmospheric condition shows no important variations except for very low and very high movements. The latter is easy to account for on the supposition that in a hurricane—such as a movement above 700 miles for the day—the children were kept at home because of the physical difficulty of getting about. It does not seem probable, however, that the decreased number for days on which there existed a virtual calm can be thus accounted for. This, it seems to me, must be an indication of disastrous effect of the condition upon health.

With regard to the effect of calms upon health, so far as I know, the only thing published is by F. A. R. Russel, Vice-President of the Royal Meteorological Society,¹ in which he states the results of a study made of the relation between death rate in London and the prevalence of low wind velocities. The conclusion of his study, briefly stated, is that the death rate for that city is considerably larger during months having many calm hours than for the months next following; or for the same month in other years when the number of calm hours is materially less. To give an example from his figures of the period from November, 1872, till December, 1893: “On the whole, the mortality is greater for calm than for windy weather, and there is much less variation in the death rate during the prevalence of strong wind than during the prevalence of gentle winds and calms.”

Although these figures are for the death rate, and that is in no sense a factor in our study of school attendance, still it is an element which varies with conditions of health, and may be taken as an indication of its state. It has also been shown that during conditions of calm the number of disease germs in the air is much greater, especially in large cities, than under other conditions; but since no known germ produces sickness upon

¹ Smithsonian Report, 1895, p. 294

the same day it is taken into the system, it need not here be taken into consideration.

Character of the Day.—We cannot be certain that more is indicated by this curve than the direct effect upon attendance of the physical difficulties of getting about during storms. Possibly the difference between the attendance on fair and on partly cloudy days is due in part to fear of a storm on the part of the parent, as indicated by the weather conditions; although days characterized under the latter head might be stormy at the beginning of the session, and hence prevent attendance. The exact differences between days of the three characters may be seen from the table on page 85.

Precipitation.—Nothing more need be said under this head than is included in the preceding.

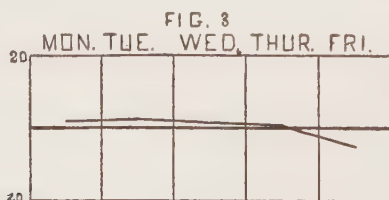
DEPORTMENT.—The attempt to discover the effect of the weather upon the children of the public schools, as shown by their deportment, was the first phase of the present problem undertaken. Indeed, in its inception it was the only study anticipated. As the work went on, however, the field broadened, and, one after another, interesting subjects of a cognate character presented themselves, until the various classes of data mentioned in Section II. were included.

The general opinions of members of the teaching profession upon the subject have been treated in the earlier pages of this section, so we shall proceed at once to an inductive study of the data presented.

Occurrence.—In the peculiar fluctuations of this curve (Fig. 9) we unquestionably have more strongly shown evidences of the force of other conditions than the meteorological. Certainly, general tendencies which might be pointed out are due to the latter; but the peculiar ups and downs are largely due to practices and customs associated with school management. A glance at the curve shows a somewhat gradual increase in the number of demerits (it seems probable that the excess for February is accidental) from the beginning of the year through June, in which month a very marked drop takes place. Again, at the beginning of the school year in September we have the deficiency still greater, with practically

an equal number for October, November and December. The regular increase toward the hotter months is in accord with the showing made by other classes of data, and is undoubtedly due to the gradually increasing temperature; but the deficiencies for July and September are not to be accounted for in that way. Were it not for the fact that all the conditions under department are studied with reference to attendance rather than registration, we might conclude that the small number of demerits given was due to a small attendance; but since the small number of school days for these months are taken into consideration we find no solution on that ground.

The explanation which seems to me most probable, and which will, I think, appeal to all teachers on careful thought, is one of the standard of discipline set for different parts of the school year. At the beginning it takes some little time for the routine to become rigid, and a laxness is allowed which would not be tolerated during other months. I believe also that at the end there is a like decrescendo in severity. A teacher recognizes the fact that in the few days remaining a misdemeanor cannot become habitual, and rather than end the year with trouble she paves her path, and that of her pupils, with roses, by overlooking many things. Both of these tendencies would lessen the number of demerits, and we here have indications of the



fact. It is not certain that the slight excess in the number of demerits for the last three months of the calendar year is brought about by the meteorological conditions. The heavy horizontal expectancy curve is in a sense an average for all the occurrences studied, and any condition forcing the curve either up or down must be compensated for by an opposite showing in some other point. The excesses for these three months may be due to the fact that the normal, or expectancy, has been so af-

fectured by the forced deficiency for the beginning and end of the school year as to leave the curve elevated at the other points, with the noted results. This factor of compensation is one common to all the curves.

The occurrence of demerits for the days of the school week is shown upon the chart (Fig. 3). It indicates a deficiency of 5% for Friday and a compensating excess distributed quite evenly for the other days of the week, though a little the greatest for Tuesday. Somewhat surprised at the fact that Friday should have been such a perfect day in deportment, I studied the data a little more closely, and discovered that it was brought about by the dominating influence of one school from which about 80% of the data had been collected. The other three schools studied showed Friday to have been the bad day of the week, but the excessive 'goodness' of the children of this school had entirely negated the result. Upon questioning the principal of the larger school with regard to Friday's program and a possible explanation, an interesting solution of the mystery was disclosed. The principal said that good order was maintained largely through an emulation on the part of the pupils to secure honorable mention at the close of Friday's session for the best deportment in the room for the week. Also, that the pupils were conscious that the teachers were on that day considering the honor roll for the week, and it seemed probable that they were all doing their best in the hope that, because of their perfection for that day, misdeeds of the earlier days of the week would be overlooked and so the coveted prize won. It was also stated that the school session was one hour shorter on Friday than on any other school day. Both of these causes would have their effects upon the curve, though the latter would have been equally potent for any of the schools studied.

Occurrence: DENVER.—The monthly occurrence curve for Denver shows all the peculiarities of that for New York, except that of increase with the approach of the heated season. The school year is considerably shorter, practically closing with May, instead of extending into July, though it begins somewhat earlier in September. We note the same excess for February, which in the case of the curve for New York was attributed to acci-

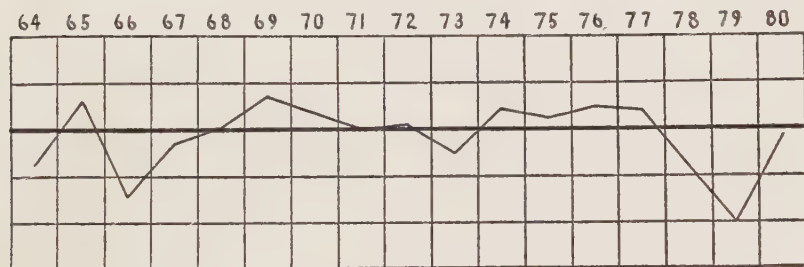
dent. Coincidences of this sort would argue definite causes which were common to both places; but what they really are it is not easy to see. For Denver the wind, which is high for the month, might be a factor; but if so, we should expect a still greater effect for the month of March, when it is still higher. This, however, is not indicated. The lack of increase in the number of misdemeanors for the heated months tallies to an extent with the showing of the temperature curve, discussed in the next paragraph. There we see that high temperature indicates a deficiency of the data considered.

Temperature.—The seeming effect of temperature upon the children in the public schools both of New York and Denver, as shown by their deportment, is different in some respects from its effect upon any of the classes of adults studied. I believe, however, it can be shown that the conditions under which we are studying them are sufficiently unlike to account for at least a great part of the differences in their curve. Reference to the temperature chart (Fig. 10) shows a less number of demerits for temperatures below 45° , an excess for the groups up to 65° and again a deficiency for those which are higher. The lessened number for all the low degrees is fully in accordance with all the results of studies of the effect of cold climates upon physical and mental activities, and is suggested by the occurrence curve, already discussed. It is a well-recognized fact that under conditions of low temperature so large a portion of the vital energy is consumed in keeping the body sufficiently warm to allow a continuance of its metabolic processes, that little is available for deportmental excesses, and a condition of comparative lethargy exists. With an increasing warmth in the atmosphere this energy is diverted into other channels, and its expenditure is made known in more conspicuous ways. Nearly all the curves upon the temperature chart show this fact. Temperatures above 65° show the opposite effect upon the school children only, by decreasing either the energy at command or the irritability which shows itself in bad conduct. Upon noting the material deficiency of deportmental excesses under very high temperature both for New York and Denver—for the latter place to the extent of

300%—it occurred to me that it might be due to a difference between the temperatures in the school-rooms and those recorded at the Weather Bureau.

The school buildings of the city are large and well ventilated, and even in summer are comparatively cool, so it seems quite probable that the contrast on a summer day with the excessive heat without might have a quieting effect, which would be noticeable in the curves. The fact that the temperature of each school-room is taken three times during each day's session, once at 10:30 A. M., once at 1:30 P. M., the beginning of the afternoon period, and again at 3:30; and that these readings were recorded in the registers placed at my disposal, made possible a study which has thrown some light upon the questions. The curve in Fig. 4 gives the result. In this curve,

FIG. 4.



as in all the others, expectancy was computed by reference to the number of times the different temperatures, indicated at the top, occurred. It will be noticed that most of the marked fluctuations of the curve are for temperatures for which the number is odd rather than even. This is undoubtedly brought about by the small number of data recorded under such conditions, due to the fact that the thermometer scale is divided into units of two degrees each, and the great majority of the teachers recorded the temperature by the nearest even number. There is a great lack of regularity in the curve; but if it shows anything, it is that for the highest temperatures recorded, which in fact run up only to 80°, there is a deficiency of demerits, while for those between 77° and 69° (with the one exception of 73°, which is an

odd number) there is an excess, and for those below 68° , with one exception, there is again a deficiency. I do not consider this curve an especially valuable one, yet its indications are somewhat interesting because of their similarity to those of the temperature curve for the year—that is, an excess only for moderately high temperatures. From this fact I would conclude that it was not wholly, if at all, the contrasting coolness of the school-room which kept the deportment good for the excessively hot day, but a relaxing effect, producing a low state of vitality which did not furnish sufficient energy to force an output in frolicsomeness. This last is true both for unusually high temperatures in the school-room and for the general meteorological condition; so much so for the latter, and so markedly in contrast with the curves for adults, as to lead one to conclude unquestionably that this effect of great heat is much greater upon the child than upon the adult. Whatever relation may exist between them in the quantity of energy each may have in reserve above what may be demanded under ordinary conditions, certain it is that in periods of excessive heat the surplus of the child seems to be exhausted much more quickly. This fact is borne out by the more rapid increase in the death rate of small children than of adults under high temperature, and, I believe, by our common observations in the matter.

Temperature: DENVER.—In considering any of the classes of data for Denver, it must be borne in mind that the numbers are much less, because of the smaller population of the city, and on this account accidental influences are much more liable to be effective and thus bring irregularities into the curves. We shall consider then that only general tendencies are valid, disregarding, for the most part, minor fluctuations. Attention should also be called to the larger meteorological groups made use of for most of the conditions. In the study of temperature, for instance, in New York, comparisons were made for each group of 5° , while for Denver 10° were taken as a unit. This is the case simply because the study for the latter city was the earlier one, and the larger groups made use of with the thought that they were exact enough. In attempting the more elaborate study for New York it was thought best to divide the groups,

even though the labor was thereby nearly doubled. Upon the charts the heavier of the vertical lines indicate the limits of the Denver groups.

Upon inspection of the curve under consideration it will be seen that there is a general resemblance to the same curve for New York, though with an intensification of the latter's results. The great excess for conditions of very low temperature is not valid, it seems to me, from the standpoint of meteorological effect: first, from the fact that the number of data for such temperatures is so limited as to make them very easily influenced by accident; and second, from the character of the data studied in Denver such accident is very probable. Those data, it will be remembered (see Section II.), were not the giving of demerits for bad deportment during the hours of the session, but the administration of corporal punishment for some misdemeanor of considerable magnitude. Misdeeds quite as frequently occurred about the school building before and after the session as during its period, and in the winter months snow-balling and the accidents connected with it were very prolific sources of the youngster's tribulations. As this pastime could only be indulged in under the condition of temperature indicated by the lower part of the curves, and as there is not, perhaps, anything quite so seductive for other temperatures, its effect may have been considerable.

If we are correct in inferring that this is a factor, we cannot assert that it accounts for the entire excess in cold snaps. It does not seem impossible that the disregard for anything else, which we are all conscious of when aching with cold, may have introduced conditions of disorder which could not be overlooked by the teacher, and so the number of castigations were augmented. The decrease under conditions of great heat may be accounted for in the same manner as the similar showing for New York, already discussed—that is, a contrasting coolness of the school-room with the atmosphere without, or the devitalizing effect of high temperatures, or both. The study of the temperatures of the New York school-rooms would lead us to believe the latter effect to be the more powerful, reducing the number of misdemeanors, under such conditions, three-fourths (300%).

Barometer.—The effect of those conditions of the atmosphere revealed by different readings of the barometer seems to be somewhat constant for all the classes of data (Fig. 11). With the sole exception of the study of errors made by clerks in banks, that effect seems to be one of increase of all the occurrences for conditions of low barometer and a corresponding decrease for readings above the normal mean. Notwithstanding the fact that the pressure of the atmosphere, varying as it does for a given locality, has been considered by many a great force in disturbing the mental and physical equilibrium of the people, I believe, as has already been stated, that it does so largely through its production of other states of weather, which are themselves the efficient cause. This is not true for the other meteorological conditions, as temperature, humidity and wind have their effect *per se*. As stated under the discussion of attendance, from the standpoint of our present study the barometer is interesting only in its relation to other conditions of weather which themselves are influential. Those upon which its variations have a causal effect are the character of the day and precipitation, and this relation is very interesting. Conditions of low barometer are usually the accompaniment of storms, although a careful study of this relation for several years shows that when a storm is of several days' duration the period of depression exists only for a short portion of that time. That is, although it is practically true that all days on which the barometer is low are stormy days, not all stormy days are those of low barometer. Now, although the curve under consideration shows an excess of demerits for low barometers, those for character of the day and precipitation (considered in full later) show a deficiency of them both for cloudy days and for those on which there is rain or snow. Our conclusion from this must be, then, that the demerits which have brought the curve above the expectancy for low barometers must have been given on the particular stormy days which presented those conditions, while stormy days when the barometer was higher were sufficiently free from demerits to force their average below the expectancy and give us a deficiency for the condition as a whole. The general tendency of this curve for the school children compared

with the others, all of which are for adults, would lead us to believe that the effect of the condition, whether immediate or secondary, is less upon children than upon adults. We must, however, take into consideration the fact that all these conclusions, which we are imputing to the effects of weather upon the children, may be little more than their effects upon their teacher.

The award of demerits is, of course, made in accordance with the judgment of the teacher, and a fluctuating criterion or a judgment warped by subjective emotional abnormality would give us the same results as a valid judgment of an affected object.

Barometer: DENVER.—Low barometers bear the same relation to the occurrence of misdemeanors for the climate of Denver that we have noted for New York, except that the effect seems to be intensified. For high readings it seems to be reversed, and at that end of the curve we again have an excess. The conditions of atmospheric pressure are, however, very different for the two places, for we must, in reading the exact height of the mercurial column for Denver, subtract five inches from the readings given at the top of each column. There seems to be nothing new to be said with respect to this curve.

Humidity.—The general tendency of this curve (Fig. 12) is to indicate an excess of demerits for conditions of low humidity, compared with the numbers shown for a moister air. Comparing it with the curves of the other classes of data, in which an emotional state affecting conduct can be considered a factor (Assault, Penitentiary and Insane), we find this tendency less marked for the children than for the adults. Judging from the answers to the syllabi with respect to the effects of ‘muggy’ and ‘sticky’ weather, I am inclined to think that this showing will be something of a surprise. The curves mentioned resemble each other so closely in their general tendencies that when we consider that nearly 100,000 data were made use of in their construction, we can hardly doubt their validity. Of the special curve under consideration, the marked fluctuations for both the end groups may or may not be due to accident. That of the group 45–50 is much more liable to be so than the one at the other extreme,

for, as we see by noting the normal prevalence curve, less data were considered in computing its position than for the latter. The curve coincides wholly with the condition which we find for character of the day and precipitation, as all these show deficient numbers of data for conditions of moisture. Our inference from this curve must be, that excessive restlessness, together with those activities of mind and body which in the judgment of the teacher constitute disorder, increase with increasing dryness. Yet a dry atmosphere is recognized the world over as a vitalizing one, having the bracing properties which we all recognize in certain characteristics of weather. A logical conclusion for the two conditions stated is that bracing conditions of atmosphere and an excess of activity accompany one another, or, to carry the logical process a little further, that those activities depend upon and are the result of excessive vitality.

In arriving at conclusions thus, by an inductive process, we are not, of course, supposing that every individual of the aggregate is subject to this law. There may be many whom such a vitalizing effect would rouse only from a chronic state of physical and mental lethargy to a condition common to the rest under less stimulating conditions; but for the pupils as a whole the conclusions are valid. Interviews which I have had with many teachers upon the subject have tended to corroborate the view taken. They say that two tendencies on the part of the pupil are to be combated—inattention and roguishness; and, however differing might be the views of individuals with regard to the distribution of the latter, the former was more prevalent, they thought, on stormy and wet days. The present study would tend to prove roguishness more common when the weather is dry and clear. This is noticeable when we consider that lapses of attention would not be so apt to influence the giving of demerits as conduct that was objectively bad. The sins recorded there are those of commission rather than of omission, as inattention would affect the class-standing rather than the record of deportment.

The cause of the exhilarating effect of a dry atmosphere seems to be the increased electrical condition accompanying it; but since this is much more markedly shown for the climate

of Denver we shall discuss it in the next paragraph. The sudden increase in the number of demerits awarded for the highest group of humidities is not wholly due to accident. It seems to me probable that we may attribute it to an utter lack of the power to inhibit, brought about by the relaxing effects of such an atmosphere. We have all recognized, I think, in ourselves or in others, a mental state brought about by weakening and relaxing influences in which any impulse was followed by its motor realization simply through an inability to control. The threshold of such a condition seems to be fairly well definable and not at all gradual. It comes after those stages of relaxation in which there is scarcely enough energy left to initiate activity, and generally shows itself in a condition of excessive nervous irritability. Although the other curves for data of this nature do not show it, and our conclusions may not be well grounded, still the possibility is, I believe, worthy of mention.

Humidity: DENVER.—The curves on the humidity chart make some of the most startling disclosures of the whole study. Whereas for New York we have slight excesses of the occurrences at low humidities, here we have for all classes of data excesses which seem almost incredible. For the school children it amounts to 400%, and for Suicide and Murder very much more. When we consider that this means that for the fourteen years studied the days on which the humidity showed a mean of below 30 had four times as many punishable misdemeanors as the law of numerical probability would lead us to expect, we cannot doubt the effect of such conditions, especially when the three curves show the same effect in differing magnitudes.

To one who has lived in Colorado and has experienced these conditions, indicated by the lower end of the curve, the results, although perhaps surprising, are still fully creditable. The effect upon the school children, and indeed upon the people as a whole, is easily recognizable, and has been alluded to in the answers to the questionnaire coming from Colorado. The effect seems to be, primarily, an excessive stimulus to nervous discharge. The low humidity common to Colorado and the higher altitudes (see Fig. 12) makes this condition, to an extent, a permanent one, and has been alluded to in Section III. But even the

chronic state of neurosis prevailing under normally low conditions of humidity is capable of intensification under those still lower, and these are what our curves give us. By 'the chronic state of neurosis' referred to, I do not mean a pathological condition, but a slightly increased nervous tension which all except the strongest and most phlegmatic feel. It shows itself frequently in mild insomnia or an occasional irritability of disposition, though not in melancholia. Even the horses are not free from the influence, and seem to be more nervous and excitable than their species in lower altitudes. This has been especially noticeable in highly bred horses which have been brought to Denver and Colorado Springs for track purposes. Not infrequently the effect has been such as to give their trainers much anxiety as to their ability to control them at all under the super-exciting conditions of the race. When, however, both with racing horses and human athletes, the effect has not been sufficient to bring on other complications, the available energy for rightly directed motor discharge has been increased, and some astonishing records are the result. The effect upon the mental worker is also recognizable. Work is, for the most part, turned off under higher pressure, with the necessary consequence that it generally cannot be so long maintained without a resulting condition of partial collapse ensuing, which demands a brief sojourn at a lower altitude for its relief. Ministers, teachers, lawyers and professional men generally feel this especially, and recognize the necessity of longer vacations than were needed by them when working at lower altitudes. The school year is shortened in accordance with this requirement, and even then the mental collapse of both pupil and teacher is usually greater than that felt by them at the conclusion of the longer school year in a more humid climate.

These effects are, I believe, not the results of dry air *per se*, but of its universally accompanying electrical condition. As was stated in Section III., the earth, for its entire surface, has been found to be charged with static electricity of a negative character. This is not supposed to be a property of the earth itself, but to be generated by the friction of objects on its surface and of air particles set in motion by the wind, under a discussion of which condition we shall again allude to it.

It is also supposed that the potential of this static charge at the surface of the earth is directly proportional to the non-conductivity of the surrounding atmosphere. If this were an absolute non-conductor, its effect would be similar to that of the glass of a Leyden jar, the earth representing one of the tinfoils of the jar and the clouds representing the other; but the properties of electrical conduction of the atmosphere decrease with its moisture or humidity, with the necessary consequence that those portions of the earth's surface which are insulated by a very dry atmosphere are continually being charged without being able to discharge convectively their burden to the clouds, or the higher strata of air which contain electricity of the opposite character. As a consequence, those regions where the humidity is low are normally more highly charged electrically than regions where the conditions of humidity are the opposite, and those regions themselves vary with respect to the potential of their charge as the humidity varies, the potential being strongest where the humidity is lowest. Actual experiment has proved that this potential is sometimes very high. Professor Arthur Schuster, F.R.S.,¹ says of it: "The strength of this electric field is not at all insignificant. If we wish to produce it artificially, between two parallel plates kept one foot apart, we should have to apply an electro-motive force sufficient, and sometimes more than sufficient, to light up the incandescent lights of our dwellings. The electric force is comparatively weak in our country (England), but 50 volts per square foot are constantly observed, and 100 volts are not uncommon; but *in drier climates the amount of force may be considerably in excess of these figures.*" The latter condition is certainly experienced in Colorado, though, so far as I know, no definite experiments have been made there to determine its magnitude. Although the electrical condition is observed for the surface of the earth, objects upon its surface would have a still higher charge. The increased tension for the static charge for projections or points upon the surface of the conductor is well known, and a human being or any other object upon the surface of the earth under such electrical conditions would show more than the full potential of its support.

¹ Smithsonian Report, 1895.

This tendency of the static charge to rush to points on the surface and thus discharge itself by convection gives rise to the phenomena of St. Elmo's Fire, or the so-called Castor and Pollux of the ancients, and also curious electrical manifestations sometimes observed on the summits of high mountains. It has been observed that the electrical potential of the air is less in the vicinity of larger towns and cities than in the open country, especially if it be free from woods. This is due in part to the effect of the numerous points presented by the buildings of the city, but still more largely, in all probability, to the discharging effects of the gases and columns of heated air arising from fires. Professor Schultze, in the paper already referred to, mentions the effects of these results of combustion, and concludes that their influence in reducing the potential in thickly settled regions must be tremendous. He says: "It follows that every fire burnt on the surface of the earth, and every chimney through which products of combustion pass, act like very effective lightning conductors, and would consequently discharge, slowly but surely, any electrification of the surface of the earth. The peculiar immunity of factory chimneys against damage by lightning appears from statistics collected by Hellman in Schleswich-Holstein, for which 6.3 churches per thousand were struck, and 8.5 windmills, the number per thousand for factory chimneys was 0.3 per thousand. It will be noted that although the action of lightning is mentioned in this quotation, the electrical conditions of the atmosphere which we have been considering are those normally prevailing without lightning or any visible electric phenomena. During a thunderstorm the potential of the earth's surface runs up to many times that of other occasions, but in the present study the mental effect of such conditions will not be considered. They are not frequent enough in most localities to form a factor in the cosmical environment; and, moreover, during the occurrence of an electrical storm the whole emotional condition of the school is so affected by fear or awe in the presence of such tremendous phenomena that no demerits could, with justice, be awarded which could be used as data for an inductive study like this.

In regard to the exact manner in which the electrical condi

tion affects us little is known. Further study along the lines of electro-physiology and psychology may demonstrate this to a certainty; but for the present we must satisfy ourselves with what little light we may show upon the magnitude of this effect alone.

Wind.—The effects of the wind upon the emotional states of the various classes of individuals as disclosed by this study have been something of a surprise. In spite of the fact that we so frequently hear people deploring conditions of considerable movement, and asserting that the wind ‘makes them nervous,’ the curves taken as a whole fail to show that high winds for the climate of New York have any effect disastrous to mental quietude. In fact, these effects seem to be the reverse, for, in spite of many fluctuations—increasing as the data for the groups become less—the general tendency of the curves is downward as they show increasing velocities from the 100–150 mile group. This is not so plainly marked for the curve under consideration (Fig. 13) as in some of the others for adults, yet that portion for movements above 500 miles indicates noticeably less data than that for the 350 miles preceding. The marked deficiency for the lowest movements recorded I am at a loss to account for. It cannot be discovered by studying the meteorological tables that such conditions are the usual accompaniments of other meteorological states which have shown a deficiency of data; nor has it seemed to be a fact of general experience that days which were virtually without wind—as those registering less than 100 miles—have had a soothing influence. Yet the uniformity of the curves in this respect leaves no room for doubt. It may be that we have a solution in the relation which seems to exist between conditions of calm and the vitality of human beings. We alluded in our discussion of attendance in the schools to discoveries with regard to these effects upon the death rate in London, and we have here evidence of an increase for days when the movement was very small. If, then, perfectly calm days have a devitalizing effect, in accordance with our theories already stated, that a certain excess of vitality is necessary to conduct warranting demerits, we might expect just the deficiency indicated by the curve.

From the 150-200 groups the curve shows a gradual though slight increase in data till we reach the 500 mark, when it declines again, the excess for the highest movement being quite likely due to accident liable to the small number of data of the group. Any attempt to account for these peculiarities in the general tendency of the curve would be little more than guesswork, although several of the other curves show practically the same conditions. It would not seem improbable for their showing that while very slight and very excessive movements affect the vital forces at command in a negative manner, the velocities between these extremes have an opposite effect, though not a very marked one, and for the latter condition alone do we have excess of the occurrences studied.

Wind: DENVER.—A glance at the curve indicating the effect of the wind upon all the classes of data studied for the city of Denver is sufficient to show that its effect in such a climate is tremendous compared with what it is for New York. While those for the latter city do not diverge far from that of *expectancy* in the dry Colorado climate, movements of only a moderate absolute velocity are accompanied by nearly five times (470%) the normal number of misdemeanors in the public schools.

A fact most surprising to one who has lived in that climate is disclosed by the chart of monthly means (Fig. 8). It is that the movement of the wind for the year is only about one-half what it is for New York. This seems hardly credible to a Coloradian, for the severest criticism of his climate which he hears—indeed his own before he became so enthusiastic over its virtues as to fail to see its defects—was on this very score of wind. The curves under consideration, however, undoubtedly prove that he has been judging the velocity of the ‘Colorado zephyrs’ by the effect which they produce upon his mental state rather than by the anerometer record, and in this way has read into it a velocity which did not exist.

By noting the wind groups covered by the Denver curves it will be seen that the greatest movements occurring for all the year studied were between 450 and 500 miles, and though there was but a small fraction of our per cent. of such days, yet their effects, and those, in fact, of all movements above 250

miles, were tremendous. The undoubted cause of this was alluded to in our discussion of the effects of low humidities in such a climate. That the wind alone is not productive of such results is shown by the study of its influence for the climate of New York. There, those velocities which are so disastrous for Denver seem productive of no mental effects whatever.

As was said in the paragraph just alluded to, the electrical potential at the earth's surface nominally increases in an inverse ratio to the humidity. It may also be said with just as much truth that, humidity remaining the same, the electrical potential increases directly as the movement of the wind. The electrical state is in every respect one of static or frictional electricity, and, just as in the physical laboratory, the electrophorus takes less rubbing or the plate machine fewer turns to become charged on a dry day than on a moist one, so in the dry climate of the west a moderate movement of the wind produces effects which no hurricanes can bring about in the relatively humid east.

No very carefully tabulated data are required to demonstrate those effects in a qualitative way. When both conditions for producing the highest potential—that is, low humidity and high wind—come together the effect upon the pupils in the schools is very noticeable. It is no uncommon thing to hear a teacher deploring the conditions because of the fact that she could ‘do nothing with the children.’ In looking over the monthly observation sheets sent by a score or more of voluntary observers in the State of Colorado to the office of the Weather Bureau at Denver, I was struck by the force of some of the comments which were frequently appended. One, made by a physician in one of the smaller mountain towns upon the point under discussion, was: “Humidity for the month very low, which has set up an electrical condition that has set every one to fussing and fighting.” Although he has considered the conditions upon which he has so tersely commented as due entirely to the humidity, the wind is also a factor in their production, and his characterization of the effects is too good to be omitted.

Character of the Day.—Surprising as it may seem to the many who have expressed their opinions in answers to the questionnaire sent out, on cloudy days the deportment in the school-

room was better than on those of any other character, if we may judge by the number of demerits given. We might be inclined to be sceptical as to the validity of the curve, even though it be based upon the tabulation of 100,000 or more actual observations, and still prefer conclusions from our experience, did not all the other curves (banks excepted) show a similar deficiency of the conditions studied for cloudy days. Whole articles have been written based upon the supposed observation that the devil openly stalks abroad on gloomy days, and that crimes are multiplied under such conditions.

Dickens could hardly find sufficient excuse for a suicide or a tragedy of any sort except under the gloomiest condition of weather.

For the curve under consideration, partly cloudy days have quite a marked excess (9.8%); fair, about the *expected* number, and cloudy, the deficiency referred to.

On the vital theory of deportment which we have made use of in discussing some of the other results we should account for this deficiency upon the relaxing or devitalizing influence of gloomy weather; that under such conditions the children as a class lacked the energy to become disorderly and were comparatively quiescent, even though they were not intellectually energetic enough to do their best work. If we had a special marking system for inattention, or if I had been successful in obtaining the much desired daily marks for the class work, I am inclined to think that this hypothesis could have been proved. As it is, the work remains to be done. Marks for deportment would not be likely to show such conditions, except in a negative way, and this, I think, we have here.

The excess of demerits of partly cloudy days may be accounted for by taking into consideration the effect of different conditions of gloominess upon the emotions and the states of vitality. Cloudiness seems to indicate the negative character of the former, and decrease the available quantity of the latter. On fair days, then, although vitality would be at an excess, positive emotional states—or good nature—would so direct its motor output as to make conflict with the authority of the teacher not very liable. On partly cloudy days the available energy has only been les-

sened to a small extent; but a markedly negative emotional condition has been brought about which directs that considerable quantum of available energy into motor channels that are disastrous to good conduct. On cloudy days, although the emotional state would bode trouble, energy is lacking, and less active disorder is possible than when a moderate amount of both its elements is present. It may perhaps be argued that such an analysis is entirely unjustifiable; that the motives which influence the conduct of the child cannot be reduced to the twofold conflict of emotional quality and vital energy. Such a criticism may be entirely just, but will have weight in proportion to the validity of other hypotheses that may be brought forward to account for the conditions demonstrated by the data.

Character of the Day: DENVER.—This curve so nearly coincides with the one just discussed for New York as to leave little to be said. The quieting effect of cloudy days for the Denver climate is much more decided, and is somewhat surprising to one who has experienced it. Upon the basis of the compound influence of emotional states and vitality we must judge from this showing that for Denver the effect of cloudy weather was either less potent in negating the emotional state or more potent in depleting the vital reserve, or both. But both of these suppositions are contrary to conclusions which experience of the occasional cloudy days of the Denver climate would lead us to make. We seem to be conscious at such times of an especially depressing effect upon the spirits, though what the influence upon vitality may be is hard to state from introspection. The Denver curves for Suicide and Murder show an opposite effect for cloudy days from that indicated by this curve, and a fuller discussion of the probable causes will be given in the sections which treat of those classes of data.

Precipitation.—The relative number of demerits given upon rainy days and upon those in which there was no precipitation is what would be naturally expected from the study for the character of the day—that is, an excess for dry days and a corresponding deficiency for rainy days. Since fair days are usually of the former character, and those on which there is precipitation of the latter, what has been said of them is valid for our present topic.

SECTION V.

SUMMARY OF OTHER CLASSES OF DATA.

It is my purpose in this section to summarize as briefly as possible the effects of the definite meteorological conditions studied upon the other classes of data mentioned in Section II. It must take the place in this paper of more exhaustive discussions of the separate classes.

OCCURRENCE.—A glance at Fig. 9 shows that for the peculiarities of conduct there is a somewhat marked increase in occurrence for the hot months. In some cases (Male Assaults notably) the curves resemble very closely those of monthly means of temperature (Fig. 8). For the Insane and Discipline in the Penitentiary the increase is much less marked, yet plainly noticeable. The curve for Suicide shows the increase much earlier in the year: so early in fact as to make it seem improbable that this is due to heat alone. Morselli ('Suicide,' International Science Series), in a most exhaustive study of suicide for European countries, has called attention to a peculiar fluctuation in the occurrence curve which coincides almost exactly with the results of this study. For many of the countries considered by him he found the maximum number for the year occur either in May or in July, with always a large excess for the spring months. That this season of the year, when all nature is in its sunniest mood and smiling in its brightest garb, should be chosen by so many as the time for exit from a world so inviting, is contrary to what an analysis of the problem would lead us to expect. There are, however, certain facts discoverable which tend to account for such seeming anomalies in conduct.

First.—It is recognized that at the end of the winter months the surplus of vital energy is at a very low point; this is not shown by the death curve, for at this period of the year diseases that usually prove fatal are not prevalent (those of the lungs and intestinal organs); but the strong man feels it, and people generally, as is shown by the demand for the so-called 'spring medicines.'

Second.—Under conditions of depleted vitality the general

emotional tone is lowered, and sometimes brought to a negative extreme.

Third.—Under such conditions of vitality impulses to action would be less liable to be inhibited; and consequently more apt to result in a motor reaction. All these conditions would tend to increase the number of suicides; but I am inclined to think that there is another cause which, added to those already mentioned, is a more immediate one. It is the conscious or unconscious contrast of the recognized low condition of vitality with the exuberance of energy and life in the rejuvenated nature about, making one who is weak feel that the struggle against the resistance to life and progress, in competition with a world so virile, is hopeless. Beside this, there is the remembrance of other seasons when the increased animation of the world about throbbed in his own pulses, bringing greater hope and aspirations. All nature is again in the flush of youth, as on so many happier occasions, when the mood of the subject was in full harmony with her; but in his present enfeebled state the vitality and life of the newly awakened spring make the contrast such a terrible one, that he is apt to cry with the author of ‘Locksley Hall:’

“Comfort? comfort scorn’d of devils! this is truth the poet sings,
That a sorrow’s crown of sorrow is remembering happier things.”¹

And to put an end to a hateful and unbearable existence.

This argument is, of course, not intended to account for suicide, but for the *excess* of suicides shown for the spring months. It would not in any sense account for self-destruction through cowardice or an inability to face the consequences of some definite misdeed, but only such as resulted from a chronic state of low vitality, either physical or mental.

The occurrence curve varying most widely from the normal is that of Discipline in the Penitentiary. In explanation of the fact that for the heated period there is no increase in the number of persons under special restraint I need only mention the fact that during the summer there are many more at work

¹ See Dante’s *Divine Comedy*, Canto V.:

“No greater grief than to remember days
Of joy when misery is at hand.”

out of doors, and by the system of rotation a large number of the convicts are thus allowed to work off their surplus energy. The fact, too, that misconduct debars one the privilege of enjoying the outer air undoubtedly proves an incentive to good behavior. To account for the fact shown by the curves for death and for suicide, that those occurrences were much less frequent for August than for July, I should say that for the two years for which they were studied (1886-87) July was much the hotter month. The curves would probably not be normal for any considerable period of time.

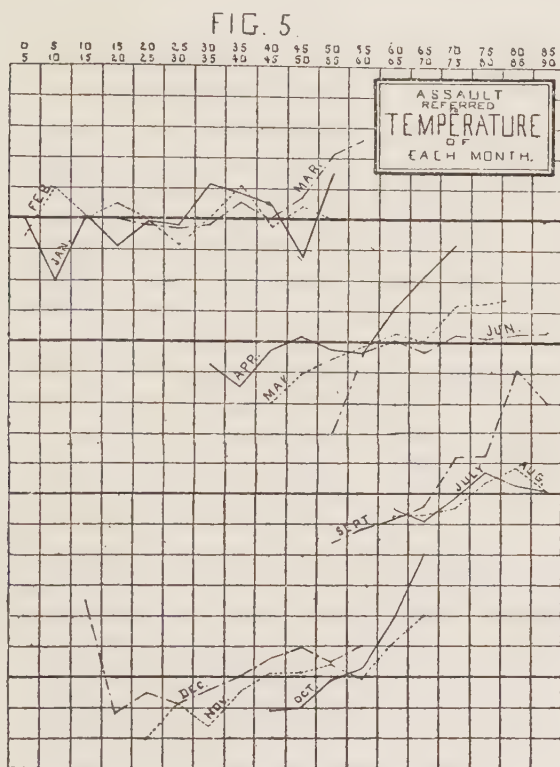
TEMPERATURE.—

“For now these hot days is the mad blood stirring.”

This quotation may, perhaps, be taken as an epitome of the results shown by Fig. 10. From them, we see that there are no exceptions to the fact that excessive heat is accompanied by an increase in occurrence. Generally speaking, this increase is somewhat gradual from the lowest temperatures to a point varying for the different curves, but uniformly somewhere between 65° and 80° , at which the increase is very much more rapid. For suicide alone is there a similar excess noted for very low temperatures; and this fact may, perhaps, be accounted for by the increased misery such conditions bring to those who are not properly housed. It will be noted that the more rapid increase for greater heat begins at a lower temperature for this class of data and also for assault. This fact leads to a more definite study of temperature conditions as follows: Since the more rapid increase for assault began at 10° or 15° lower than for most other classes, it seemed evident that there might be conditions of heat which would fail to show upon these general curves as effective, even though their influence be considerable. Such would be unseasonable heat—that is, excessively hot days *for the time of year*, though in actual temperature only equal to comparatively cool ones for a hotter season. To explain by using a concrete example:

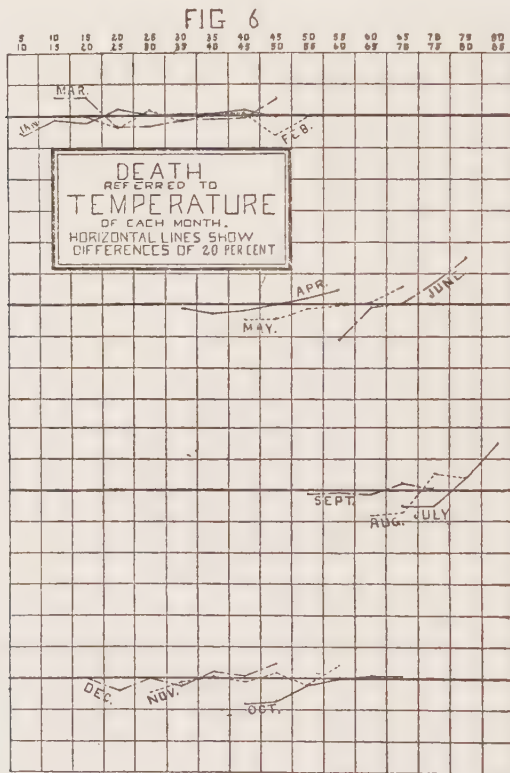
An April day of a mean temperature of 70° might, for all this curve shows, have a disastrous effect upon general conduct; yet in the study of that condition for the year the fact might be entirely concealed by the reverse effect of an August day of the

same temperature. In order to discover such mutual negating of results Fig. 5 was prepared, upon which are shown the temperature curves for male assaults for each month of the



year. Although this figure is not elsewhere explained, it is constructed in every respect upon the same principles as the others, and shows some exceedingly interesting things, especially when studied in connection with Fig. 6, the only other figure showing monthly temperature curves. The curves interpreted show that in Jan. and Feb. the temperature variations have very little effect—that is, the curve has no very marked general tendency either up or down, the fluctuations being probably due to accidental conditions which a larger number of data would tend to eliminate. In March the hot days are beginning to have their effect, which in April is at its maximum, decreasing as the

heat of summer comes on, and increasing again, till an autumnal climax is reached in October, with another decrescendo effect for hot days as winter approaches. The unusual and interesting fact demonstrated here with a certainty that cannot be doubted, is that the unseasonably hot days of spring and autumn are the pugnacious ones, even though the actual heat be much less than that for summer. In fact, it will be noticed that for the excessively hot days, registering a mean of from 80° to 90° , the number of assaults for at least three of the



months upon which that condition is reached (July, Aug. and Sept.) decreases. We might infer from this that conditions of heat up to a certain limit are vitalizing in their tendency, while at the same time irritating, especially when we are not dressed in accordance with the demands of comfort; but above that

limit heat is so devitalizing in its effect as to leave hardly energy enough to carry on a fight. This devitalizing influence of high temperature is especially shown in our treatment of the death rate, indicating, as it does, that deaths increase with an absolute increase in temperature, and not with unseasonable heat, as was the case for assault. The special curves (Fig. 6) for the first three and the last two months of the year show little increase as affected by temperature. For the intervening months we have a somewhat gradual rise with the temperature, which reaches its climax in the months of June and July. That August does not show as marked an effect is undoubtedly due to the lower mean for the month, alluded to under our discussion of occurrence in this section. The results of these curves are more interesting in the setting which they furnish for the similar one for assault, than for any absolute value they have of their own. The facts which they disclose are only those which would be naturally expected—that is, that under conditions of excessive heat the general metabolism of life processes is so increased as to leave little surplus of vitality to be drawn upon by the accidents of sickness or other contingencies.

The very excessive increase in the number being disciplined in the penitentiary under conditions of great heat may, it seems to me, mean either one or both of two things: that those at work upon the grounds were emotionally affected by such conditions, while still retaining energy enough to be actively ugly—energy normally being at a surplus because of the light drafts made upon it in such institutions; or it may be an evidence of the poor ventilation and sanitary condition of the cells or rooms of detention. The school children—the only other class whose deportment we have studied for indoor condition—show reverse effects for temperatures as registered at the Weather Bureau. In accounting for this, I argued that the cool, well-ventilated school-rooms were undoubtedly a factor; for the conditions as found at the penitentiary we might argue the reverse. The relations of the curves for the different sexes where they were studied separately (as in the case of Assault and Insane) lead to an interesting conclusion: it is that the effect of heat upon females is greater than upon males. This is shown both in an increased pug-

nacity and in a greater mental unbalancing. Especially in the prevalence of assault is it noticeable. Starting at the lower temperature with a deficiency much greater than that for males, the curve indicates a somewhat gradual increase to an excess of 100%, or double the expected number, for the temperature groups 80° to 85°, at which point it makes a drop to 33%. The curve for males shows neither extreme so far from expectancy, nor is the drop at the end so marked. This sudden falling off of assaults for the most excessive heat is, I believe, a very interesting fact; but since conclusions are drawn from it which are discussed in the next section, I merely call attention to it here. The greater sensitiveness of woman to weather conditions was noted by at least one of the teachers in discussing the answers to the questionnaire. The physiological conditions which bring about an unequal distribution, in point of time, of demand upon the vital energy upon the sex are undoubtedly its causes. Without question, during periods when this demand is greatest the emotions are less stable and the weather effects much greater than for periods when those demands are less.

BAROMETER.—There is a greater resemblance between the effects upon the different classes of data studied, of those meteorological conditions of which the barometer is the measure, than of those of any other weather state (see Fig. 11). With the exception of the curve for Errors in Banks, the various curves might be superposed, and, except for minor fluctuations, would practically coincide. Death and Suicide were not, however, studied for this condition, owing to a difficulty in getting the record for the years 1886-7, for it is possible we might find a somewhat greater divergence. The fact disclosed is that—save for the exception cited—there is an excess for all occurrences for relatively low readings, and a corresponding deficiency for high ones. As has been stated elsewhere (Sec. III.), it does not seem probable that the definite state of the atmosphere revealed by the barometer is itself the direct cause of the variation, so much as other weather states which are their concomitants. Since, however, the other curves so nearly resemble that for deportment in the schools, which was somewhat fully discussed in the chapter just referred to, we need mention here only the diver-

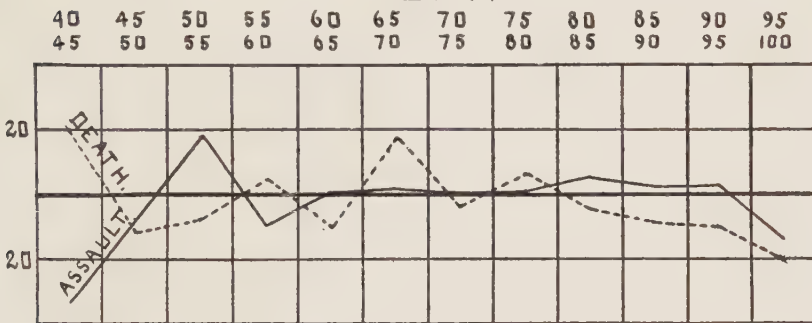
gent one of Errors in Banks. As a glance at it shows, there seems to be no general effect of the different barometric conditions upon their occurrence, although errors seem to be slightly less in number for conditions of low barometer than for high. As a basis for its consideration, we must conclude that the other curves indicate a less full control of the emotions for low barometers than for high. Reasoning from these facts, my conclusion is that the errors studied are more in number when mental—or at least emotional—states are under most perfect control. This, however, seems contrary to all opinions based upon introspection or general observation, and leads to an analysis of the conditions under which the errors were made in search for any other hypothesis in explanation of the facts. A possible one is found as a result of conference with the offending individuals themselves. It is that on some days they seem to feel a confidence in themselves which leads them to pass off work as perfect at the first attempt; a computation is rapidly made, or a column of figures added, and another piece of work undertaken, without a second thought as to the correctness of either. This is the case on days when they feel their *best*. On other days a greater possibility of error seems to be recognized, based upon the way they feel, and greater care is taken with each process, or the work is even done again in order to prevent errors which are thought to be probable in their then mental state. If these facts be true, the result would be just what we find for our curve. An increased tendency inhibited with more than a compensating care would give a negative result; yet in this case our results are not those of weather effects upon mental states, except as those effects are especially compensated for by volition, and we cannot quote the readings of this curve as normal for the influence of the barometer upon intellectual activities. It is quite probable that, at least for the teachers in the schools, there is a similar restraint based upon recognized tendencies, which would serve to negative the tabulated effects of the weather upon conduct. In fact, if this study is to be of any practical value to them, it can be so only in pointing out the conditions under which such restraint must be exercised, as well as allowances made for others.

HUMIDITY.—The curves for humidity (see Fig. 12) may be divided into two general classes: those showing a decrease of occurrences as the humidity increases, and those which show no marked tendency either way. To the former class belong those of Assault, the Insane and Discipline in the Penitentiary; to the latter, Death, Suicide and Errors in Banks. No class of data studied shows an increase, unless it be a slight one for the last named, with increasing humidity. This fact is, I believe, rather surprising, for it seems to be a prevalent opinion that occurrences of the nature considered are excessive upon humid days. Indeed, it is so certain that under such conditions we, in some indefinable way, feel ourselves out of our normal balance, that I should be inclined to doubt the correctness of a single curve; but with six (including that for the schools), based upon the results of nearly 100,000 data, all showing the same trend, we can hardly doubt their validity.

It will be noted also that all five of the curves treated in this section showing the general decline with increasing humidity make a somewhat sudden drop for the highest groups. Nor can this drop be accidental, for reference to the curve of Normal Prevalence shows that too large a percentage of the data (3%) occurs in the 95–100 groups to make this probable. It must, seemingly, be due to weather effects. In the light of facts demonstrated in other parts of this paper, it would seem as if the condition of humidity brought about the results indicated, through its effect upon the reserve energy. An excess of energy is required to produce the abnormalities in conduct treated in the first class—that is, Assault, Misdemeanor in the Penitentiary and, perhaps, the active symptoms of Insanity; while Death, Suicide and mental inexactness are results of the deficient state. Yet both the chilly, damp days of winter and the muggy, sticky days of summer have high humidities. This fact led me to question if an emotionally quieting effect might not accompany the former, and one of a reverse influence, the latter; yet the two so negative each other's effects when taken together as to fail to represent fairly the condition. Fig. 7 was constructed as the result of attempts to show the effect of humidity when an accompaniment of high temperatures only. It was made for

male Assault and Death as the two classes having the largest number of data, and consequently less liable to be affected by accident. In their preparation the effect of humidity upon their occurrence for days when the temperature was 70° or over was studied; in other words, an attempt was made to find whether humid, hot days, or dry, hot days were more productive of these results. We see that even for those days whose temperature was within an arbitrary group of 70° to 95° the

FIG. 7.



varying condition of humidity had but a comparatively unimportant effect, and that of a character which we should hardly expect. If the curves show any general tendency, it is one of decrease of occurrence for high humidities, for both curves show a somewhat marked deficiency for the highest group.

However, I do not consider these curves of much value, for two reasons: First, the number of days upon which they are based is too small. There is an average of only 61 days each year having a mean temperature above 70° , and this gave us but 122 for the Death curve and only 2 each for the humidity groups 95-100, 40-45 and 45-50, and but 8 for those of 85-90 and 90-95. This number is altogether inadequate, as accidents might easily affect the results. Secondly, the excessively hot days of our extended temperature groups were seldom those of the highest humidity. When those two conditions do come together the results are known to be very disastrous; but for the period studied the reverse was true. This fact could not help affecting our results very materially. Our temperature curves (Fig.

10) have shown the great effect of high temperature, and this means that on the hottest days would be expected the greatest number of Assaults and Death. If, however, those hottest days were, as seems to have been the case, almost universally days of low humidity, we might have the result shown by Fig. 7, or even a more marked excess for lower humidities. This source of error might have been lessened by making use of a smaller temperature group; but this would have materially cut down the number of data, and so made prominent the other horn of our dilemma.

To return again to the general curves upon Fig. 12. The slight excess for lower humidities may, perhaps, be ascribed to the increased electrical potential for such conditions. Although this electrical state has been described (Section III.) as existing at every point upon the earth's surface and for any climate, it has not been found to be very great except for lower humidities than are common for New York (see Denver curve), at which point it makes a great jump. The fact has not been fully determined, although it is quite probable that the potential bears a somewhat constant inverse ratio to the humidity. If this be true, our excess of data shown for low humidities may be accounted for as was the very marked one for the Denver school children under still lower conditions.

The curve showing the prevalence of Errors in Banks is interesting, because it comprises the only class of data which are based upon intellectual processes pure and simple. The excess for the lowest humidities might indicate, if it be not due to accident, that the intellectual balance is more disturbed by the increased electrical potential than is the emotional. The gradual rise in the curve from the 50-55 to the 95-100 group indicates that the devitalizing effect of increasing conditions of moisture have so exhausted the energy applicable to mental processes as to affect their regularity and perfection.

WIND.—Generalizing from the effects of the wind upon the occurrence of data as shown by the curves upon Fig. 13, I should say that calm and high winds are accompanied by a decrease in their number, while moderately high winds show a corresponding increase. The exceptions to this are death, suicide and errors in banks, for which the general maximum of occur-

rence is during calms. These disclosures are, I believe, somewhat startling, as our own feelings in the matter would lead us to think otherwise. Daily movements of from 100 to 200 miles, for which conditions many of the curves show the maximum of occurrence, are those ordinarily considered most agreeable and bracing. That the greatest number of Suicides, attacks of insanity and assault should occur then does not seem easy to understand, especially in the light of opinion expressed in answer to the questionnaire, for such days could hardly have been classed as 'Windy.' There is, however, the possibility that on such days nearly all the movement of the wind registered for the day took place within a limited time, in which case they might naturally have been considered so.

Perhaps the effect of conditions of calm upon different individuals varies with the personal temperament and with the time of year. It seems certain that a calm day during the heated summer season is depressing, while a similar condition for other times of the year has a reverse effect, both emotionally and in its relation to vital energy. The deficiency of occurrences as shown by the curves for such conditions may be contributed to by both these states: the former, by so depleting the energy at command as to lessen the numbers; and the latter, by increasing the energy without affecting the emotions in such a way as to direct its output into channels productive of misdemeanor. In this case intellectual activities might, if we had sufficient data, be shown to be the result.

It will be noted that death and suicide are both somewhat excessive for conditions of calm. In regard to the former, the fact was noted in a reference to studies made in London. In a large city like New York the fact may be due to the lessened proportion of oxygen in the atmosphere, because of the depletion by respiration and fires without fresh air being brought in to replace it, and the consequent increase of carbonic acid gas. Dr. J. B. Cohen¹ has shown that the proportion of this gas in the atmosphere in the center of the town of Manchester, England, averages nearly three times (for some observations more than four times) that in the outskirts. Although he makes no

¹ See Smithsonian Reports, 1895, p. 573.

reference to the fact, it would seem probable that the differences which he found may have been due very largely to differences in circulation brought about by varying velocities of the wind. Certainly when the movement was very violent but little difference could exist in the composition of the city air and in that of the country. Recognizing the importance of oxygen and the disastrous effects of carbon dioxide upon the metabolism of life, it would not be strange if the conditions shown by our curves were in some way influenced by their varying quantities. In fact, basing conclusions upon the theory of vitality already expressed, we should expect just what is shown by them—that is, if an insufficiency of oxygen and the universally accompanying excess of carbon dioxide be devitalizing conditions, under them we might expect a deficiency of misdemeanors due to activity and an excess of those of a passive nature.

Those of the first class mentioned would be assaults, misdemeanors in school and penitentiary and initial attacks of insanity, all of which show a deficiency for calms. To the latter class would belong death, and possibly suicides, both of which are excessive for the same conditions. Errors in Banks might also, it seems to me, be classed with the latter. Certainly deficient energy, unless in some way compensated for, would tend to introduce imperfection into intellectual processes. For this class of data we have the *expected* number for calms.

CHARACTER OF THE DAY AND PRECIPITATION.—The effects of days of different characters, according to the nomenclature of the Weather Bureau (as shown by the curves upon Fig. 14), seem also contrary to general opinion upon the matter. With the sole exception of Errors in Banks and Death, there were more occurrences of every class studied for fair days than for cloudy days. In some cases, however, there were more for those characterized as partly cloudy than for fair. The curves for Precipitation, with the exceptions noted, also show universal excesses for those days on which there was no rain or snow. Considering the greater excuse one has to be out of sorts on rainy or cloudy days, as when the pleasure of a picnic or excursion into the country has to be foregone because of unpropitious weather, this fact is quite surprising. Even the suicide

chooses the fair day for self-annihilation (except in the Denver climate), and seems to have a very marked aversion to rainy weather. The relation between the curve for Character of the Day and that for Precipitation for the same class of data throws additional light upon the exact kind of day chosen. Attention has been called to the fact that not all cloudy days are rainy days; nor are all those upon which there is precipitation necessarily characterized as cloudy, or even partly cloudy. Comparing the relative deficiencies of a given class of data for cloudy days and for those showing precipitation, we can discuss the effects of those gloomy days which we all know so well, when the sky is overcast or perhaps the atmosphere full of fog, but on which no rain falls. As an example, we may compare the curves for suicide under the two conditions, and we see that for cloudy days there is shown a deficiency of 4%, while rainy days indicate one of 14%. This means that although the number for both conditions was less than *expectancy*, there were relatively more suicides for cloudy than for rainy days. Now it would be safe to say that nearly all the rainy days were characterized as cloudy, but that the former only made up a portion of the latter. The remainder, which would be cloudy, but not rainy, would have to account for the difference of 10% shown by the two curves. This must mean that, of the cloudy days, those which were without rain were accompanied by the greater number of suicides.

All the sets of curves may be considered in the same way, and, as a matter of fact, nearly all would show the same effect for days overcast yet without rain. I recognize a possible fallacy in this argument, from the fact that in each of the curves for character of the day three conditions are shown, while for precipitation there are but two; yet for many of the classes of data the number for at least one of the three characterizations of the day is so near the *expectancy* that it can hardly have much effect upon the result.

The question might be asked as to the effect of foggy days. No special study has been made of them, but an analysis of the curves under consideration might in part answer it. Days upon which there is fog might come under any one of the five condi-

tions of the two curves. If they were accompanied by no precipitation, they would be characterized as fair, partly cloudy or cloudy, according to the duration of the fog. Most of the foggy days in New York, however, are accompanied by more or less precipitation, and I am inclined to think that those portions of the two curves under 'Cloudy' and ' + or inch ' would include a great majority of them. It would seem that such were accompanied by deficiencies in occurrence in all the data studied except Errors in Banks, and perhaps Death, which contradicts itself in this respect slightly.

Upon the same theory which has been stated in other paragraphs, we should say that such days are devitalizing. There are reasons for believing that they are so from a mere study of the chemistry of the atmosphere at such times. In the paper referred to under the topic 'Wind,' a further analysis of the air is given for clear and for foggy days. The figures there show that under the latter condition the volume of carbon dioxide is from two to three times what it is under clear skies, the volume increasing in proportion to the duration of the fog. We found that when a similar excess of this poison existed in the atmosphere because of lack of wind to carry it away all the curves bore the same relation to the *expectancy*, and each is corroborative of the other's evidence that devitalizing atmospheric conditions, whatever may be their effect upon the emotions, are inhibitive of action.

SECTION VI.

CONCLUSION.

In conclusion I wish to submit the following theses, and outline in brief arguments in their defence based upon the results of this study :

First.—Varying meteorological conditions affect directly the metabolism of life.

Second.—The 'reserve energy' capable of being utilized for intellectual processes and activities other than those of the vital organs is influenced to a marked degree by meteorological conditions.

Third.—The quality of the emotional state is plainly influenced.

Fourth.—The reserve energy and the emotional state are both factors in the determination of conduct.

Fifth.—Conduct, in the commonly accepted sense of the term, Death and Intellectual and Physical Labor bear very different relations to reserve energy.

The first thesis must be supported entirely from our study of death rate and disease, as in all the other classes of data we deal with a utilization of the 'reserve energy.' Any alteration in the death rate traceable to the weather is directly in support of this thesis, for disease is but another name for some pathological condition of the body, and any pathological condition is but a derangement of its metabolic processes. Even if this derangement be due immediately to the action of some germ, any variation in the activity of the processes which are shown to be closely related to differing meteorological conditions must be attributed either to the effects of these conditions upon the germ or the organism supporting it. Since germs have been proved to be such hardy little creatures, we are forced to suppose the effects to be upon the organism. For whatever meteorological conditions, then, we find a well-marked excess or deficiency in the death rate, or even the attendance at the public schools—if our supposition was correct that this was influenced by health—we may conclude that an effect upon the metabolic processes of life is indicated. Such an effect may be either favorable or unfavorable to health. Favorable conditions would be shown by a decrease in deaths and an increase in school attendance; unfavorable conditions, by the reverse. A study of the curves for Death and Attendance shows that generally low conditions of temperature, humidity and wind are favorable, as shown by a deficiency of deaths and an increased school attendance, while partly cloudy and dry days seem to be somewhat so, if we make allowance for the direct effect of such conditions upon the ability of the school children to get out. On the contrary, high temperature and humidity, and moderately high winds, together with rainy, fair and cloudy days, are somewhat unfavorable. These conditions seem so different, basing our judgment upon general experiences, as to lead to a further analysis of the unfavorable conditions. Some of them have been shown to be of

such a character as to accelerate the oxidizing processes of life, and others to retard them : the former I shall call *anabolic* ; the latter, *katabolic* conditions. High temperature, high winds (better ventilation), fair days (see page 72) with low humidities as an accompaniment are *anabolic* ; while low temperatures, high barometric conditions, calms, rainy and cloudy days and high humidities, because of their opposite characteristics, are *katabolic*. Now it may be seen that health, which means a metabolism of the definite rapidity demanded by nature, and brought about by a long series of natural selections, may be affected disastrously either by an acceleration or a retardation of those processes. A fire may go out either from lack of fuel (too rapid oxidation) or from lack of draft (too little oxygen). The same fact is shown in a definite manner by our study for the metabolic processes of life. Those conditions which I have termed *anabolic* produce too rapid a metabolism to be borne by the weakened organism, while the *katabolic* so lessen the production of available energy as to reduce its quantity below the minimum required for life or health. A study of the various curves of the death rates and school attendance shows that, generally speaking, the so-called *katabolic* conditions are the vitally depleting ones. The marked exception is found in the showing for high temperature (mentioned later in this section) ; but the fact is plainly true for calms, high humidities, low barometric conditions, and to an extent for cloudy and rainy days. These conditions have all been classified as *katabolic*. For them the death rate is high and attendance low. This is not strictly true for the death rate upon rainy days when compared with *expectancy*, but taking the curves of conduct as our basis of comparison rainy days showed a very marked excess. These relations, considered in the light of our already defined use of the term *katabolic* as applied to meteorological conditions, show that vitality is depleted and that the spark of life goes out because of the retardation of the metabolic processes, rather than an acceleration of them to an extent that depletes the cell structure. If an animal were placed in an atmosphere of pure oxygen, death would ensue from the latter cause ; such a condition would be *anabolic* in the extreme. Although the variations in

the life-giving element of our atmospheric air, or of carbon dioxide, the death-dealing component, are not great, still they are of sufficient magnitude to be effective, and we must conclude that the vital fires are quenched for want of the supporting medium, rather than that they burn out from lack of fuel.

My use of the terms *anabolic* and *katabolic* is open to criticism, and I should not attempt to uphold it except that there seem to be no other available terms, and with the exact definition which I have given of their use in this study, a definite conception may be imparted without circumlocution.

Second.—If the first thesis be granted, the second is valid as a direct consequence; the sum total of the vital energy of any organism would consist of the energy which is being used by and is necessary to, the vital processes of living, plus a remainder, which may be utilized for intellectual processes and the motor activities accidental to life. The latter I have designated as *reserve energy*. Granting the first thesis, that the metabolism of life is affected by the condition studied, it must follow that the sum total of energy which depends directly upon such processes must vary also. The sum total of energy is made up of the potential energy of vital reserve and the kinetic of vital processes; but this latter remains more nearly constant, so that any variation in the sum must be largely a variation in the other component—that is, reserve energy. This is an important fact, and on it depend largely the conclusions drawn from this study.

The reserve energy is interesting in its relation to the life history of an individual. During the period of growth it seems to be universally excessive for persons in good health. It shows itself in the play and spontaneous activities of childhood, and the athletic sports and intellectual development of youth. During the period of maturity it has a strong balance in its favor, unless depleted by special demands made upon it; while old age gradually lessens its quantity, till the sum total of bodily energy only equals that being used in life processes. Under such conditions any extra demand necessitates a draft upon the latter, and if it be too heavy, the whole process stops. But beside the life rhythm in the reserve energy, there are many others due to

the accidental conditions of bodily health. We all recognize them, and they need not be discussed here. The rhythm which we hope to demonstrate is one of less marked fluctuation; one not of health and disease in the ordinarily accepted sense of the terms, but one of exhilaration and depression, of activity and lassitude, of good spirits and poor. Not these conditions as the traceable effects of actual bodily disease, but coming whence we cannot tell, and why, it is beyond our power to discover. This rhythm it is that the subtle agency of weather seems to affect. As a consequence of our method of reasoning, those definite meteorological conditions which were designated in the discussion of the first thesis as *anabolic*, would be those which in this varying weather rhythm would have the greatest reserve energy, the reason being that for them the metabolic processes which are the generators of bodily energy are accelerated more than the demands made upon them by the vital processes are increased. There seems to be one marked exception to this generation of energy and the demands made upon it by vital processes, and that is, for excessively high temperatures. For such conditions the vital demand exceeds the production, and the reserve is depleted or exhausted. This is shown by the great increase in Death and the sudden decrease in Assault shown upon Fig. 10 for the highest groups, but especially by the curves upon Fig. 5. The latter show no increase in Assault for the highest temperatures of July and August, while the actually cooler days of April and October, though the hottest for those months, show marked effects. It seems to me probable that the low vital reserve for excessively high temperatures may be due in part at least to the increased energy required by the accelerated secretion of the glands belonging to the excretory system. Large amounts of perspiration can be produced only at the expense of some form of energy, and since that is a process certainly abnormal at such times, it may be something of a drain upon vitality. This theory is, perhaps, corroborated by the etiology of sunstroke. This only occurs when perspiration has ceased, at which time the high bodily temperature and the activity of the metabolic process may mean more than mere failure to reduce the former by evaporation. The conditions which

were characterized in the discussions of the first thesis as *anabolic* were high temperatures, considerable movements of the wind, fair, dry days and low humidities ; but with few exceptions, and none for conduct in its accepted sense, all those conditions are accompanied by excesses in the various classes of data studied. Our conclusion then must be that increased vital reserve tends to increase the number of misdemeanors classified under Conduct.

Third.—This thesis must be defended by means of an analysis based solely upon introspection. Considering the importance that has been laid upon the question of reserve energy, it would not be safe to conclude that an excess shown by any one of the curves, even of such occurrences as Assault, is due to the effect of the conditions of the emotions alone. We are all, however, conscious of the emotionally depressing effects of some states of the weather. Nothing even that any inductive study might show could disabuse us of our belief. For ourselves, too, we are certain as to the exact conditions of weather which have a most negative effect upon them ; these may vary with different individuals, but after all they are pretty constant. Just what the middle link of the chain which connects body and mind may be is unimportant from our present point of view. It may be, and perhaps is, something closely connected with the reserve energy ; if so, we are not certain, and can disregard the ‘*quia*’ for the ‘*quod*.’

It is safe to say that high conditions of temperature and humidity, cloudy and rainy days, and for many people high winds, are generally productive of more or less negative emotional states, while moderate and cool temperatures, low humidities, mild winds and clear, dry days are usually positive in their effects. With this, we leave the thesis for the next.

Fourth.—In the discussion of this thesis we must discover the relation existing between reserve energy and the emotions, for meteorological conditions showing marked excesses or deficiencies of data. A disorderly act of the nature of an assault or misdemeanor in the penitentiary, can only occur at such a time as there may be both energy and inclination, or impulse to undertake it. The former must bear some relation to the reserve

energy; the latter, to the emotional state, which would at the instant be negative in its quality. We have traced the relation between the occurrences taken as data of deportment and the reserve energy; we have stated that—arrived at by introspection and general experience—the days upon which we most often find ourselves ‘out of sorts’ (a negative emotional state) are the hot, humid, cloudy and perhaps rainy ones, some of us reserving the right to be hard to get along with when the wind is high. Such are the days when, all other things being equal, we should be most liable to have trouble with teacher or fellow-man, *if the emotional state were the only factor*. But we find that for some at least of these ‘ugly’ days the numbers of misdemeanors alluded to are much below expectancy. Such is the case—*mirabile dictu*—for the humid, the very windy, the cloudy and the rainy days. We should be at a loss to account for such a showing did not the conclusions from our study of the reserve energy come to our aid; for all the conditions noted this was found to be very much depleted. This fact is undoubtedly the cause of the deficiencies shown. A most ardent desire to hurt somebody is not very dangerous if there is nothing to back it up. A most uncomfortable atmosphere might hover about, and a record of profanity might show some interesting things; but *inclination* alone will at least get no one into the police court. Reserve energy, on the other hand, seems a most dangerous thing to have about, as far as personal conflicts are concerned. With the consciousness of power to maintain one’s position, even by strength of arms, the opportunity under the most favorable emotional condition seems likely to arise. At any rate, our curves show the balance in favor of the influence of reserve energy, accompanying the best of spirits, over vital deficiency and most unhappy states of mind. If we could have made this study in colonial days, and have taken our records from the ducking-stool, the curves might have been very different.

Fifth.—In the discussion of the first thesis we showed the relation existing between the Death rate and the various meteorological conditions studied. In considering the second and fourth we have shown that relation for the data of Conduct.

Reference to the statements there made or to the charts themselves shows that in some notable respects the curves differ from one another. I wish here to compare the curve for Errors in Banks—the only one showing intellectual processes pure and simple—and that for Suicide, with those for Death and Conduct, to see which one of the latter the former more nearly resemble. Incidentally, too, I shall wish to refer to the study of Physical Strength, as exerted to its maximum, in the tests which have been made under my direction in the Columbia University Gymnasium. The results of the latter study could not well be shown upon the charts published with this paper, and as no definite discussion of the problem is included, no special figures for the illustration of the few points here made are given.

First, the general effect of conditions which I have designated as *katabolic* has been to increase the death rate.

Second, the general effect of *anabolic* conditions has been to increase the data of Conduct. There are some exceptions to both these statements, notably that of high temperature upon the Death rate, which has been touched upon and hypothetically accounted for; still, as a whole, the statements are valid. Tracing the curve for Errors in Banks upon the various charts, we are convinced that they more nearly resemble those for Death than for Conduct. On the temperature chart, Fig. 10, all the curves (except that for the school children) show the same general tendencies. On that for humidity the curve for the Errors in Banks closely resembles that for Death, both showing excesses for high humidity in marked contrast to those for Conduct. For Wind, it resembles the death rate in showing no deficiency for calm, though for the rest of its course it is more similar to the Conduct curve. For cloudy days it and the Death curve are the only ones giving expectancy or more, and for rainy days they are the only ones not showing a marked deficiency. Without discussing this curve further, we assert that its resemblance to that for Death is much closer than to those for Conduct. This is, perhaps, only what should have been expected, since in both the intellectual work of the bank clerks and the vital processes of life actual demands upon the reserve energy are made.

The barometric conditions, which have been wholly omitted

from the discussion in this chapter because they were not available in our study of the death rate, show an interesting discrepancy for the errors in banks curve. This cannot be interpreted in terms of comparison with anything but the curves for Conduct; still they are perhaps suggestive of the position of that for Death, if it were computed.

Without discussing the Suicide curve in detail, we can say that in many respects it is midway between those for Death and Conduct in many of its showings. For humidity in particular it closely resembles the former. An analysis of the mental and physical states which would most likely give rise to suicide would suggest those of a negative quality coupled with those of a depleted reserve energy. Each of these is the accompaniment preëminently of one of the classes of data which we have been considering; the former of excesses in Conduct, and the latter of Death. But their relation to one another in the suicide is one which we cannot hope to discover in this problem, though the relation of the curves may perhaps throw some little light upon it.

The study of the effects of the weather conditions upon the physical strength of the students in the gymnasium is at the time of writing not completed, and a report of progress only can be made. It, however, closely resembles the curve for the death rate, in that it shows deficiencies in strength for the *katabolic* condition.

As a conclusion, it would seemingly be safe to say that of the activities (or cessation of activity) possible to human beings, some are the result of excessive vitality, and others of deficient states; and that, generally speaking, those misdemeanors which have been classed under our study as those of Conduct are the results of the former, while death is an accompaniment of the latter.

I must add that I fully recognize that an insufficient number of data have been considered to give my conclusions anything like the validity which should be desired, and also that many possible classes of data have not been treated at all; but I feel justified in offering the study as a modest contribution to the knowledge upon the subject, with the hope of supplying at some future time many of its deficiencies.

TABLES.

The numbers in the following tables are those upon which the curves at the end of this paper are based. They all represent percentages. Those in the line headed *NORMAL* show the *normal prevalence* or expectancy for the condition above each. Those after the name of each class of data, the *occurrence* for the condition. The line below, in each case, the relation of *occurrence* to *expectancy*. School data, Death and Suicide are referred to a special normal, not given.

OCCURRENCE.

Norm.	Jan. 8.2	Feb. 7.7	Mar. 8.5	Apr. 8.2	May. 8.5	June. 8.2	July. 8.5	Aug. 8.5	Sept. 8.2	Oct. 8.2	Nov. 8.2	Dec. 8.5
School.	8.1	9.6	9.8	10.7	12.3	13.2	.8		3.2	12.9	10.2	9.6
	-19	+3	-7	± 0	+17	+32	-20		-55	+8.	+7	+7
M. As't.	6.7	6.2	7.2	7.6	8.9	10.	10.9	10.3	9.2	8.2	7.4	7.5
	-21	-19	-14	-7	+7	+22	+28	+21	+12	-4	-9	-13
F. As't.	5.3	5.5	6.4	6.4	9.	11.4	11.5	14.3	10.	7.8	6.5	6.3
	-37	-30.	-24	-22	+6	+38	+38	+68	+22	-8	-21	-14
Pen.	9.8	7.5	9.4	9.	8.1	8.2	7.5	9.3	8.3	7.8	7.4	7.4
	+15	-3	+10	+10	-1	± 0	-12	+9	+1	-9	-10	-13
M. Ins.	8.2	6.3	9.3	8.1	9.7	9.5	9.3	8.9	8.	7.1	6.8	8.5
	-4	-18	+9	-1	+14	+15	+9	+5	+2	-6	-17	± 0
F. Ins.	7.3	7.5	9.5	8.6	10.4	9.6	8.	8.5	9.1	8.5	5.4	7.3
	-14	-3	+12	+5	+22	+17	-6	± 0	+11	± 0	-34	-14
Death.	8.5	7.7	8.7	8.	7.7	7.9	11.8	8.6	6.	7.7	7.8	8.9
	± 0	± 0	+2	-2	-10	-4	+39	+8	-7	-9	-5	+5
Suicide.	5.9	7.3	7.4	9.2	10.3	8.7	12.4	10.4	8.	8.5	5.9	7.2
	-30	-5	-3	+12	+25	+6	+46	+23	-1	± 0	-30	-16
Banks.	7.4	7.4	8.7	7.1	7.4	8.7	10.	9.3	7.8	8.7	8.9	8.9
	-13	-4	+2	-13	-12	+6	+17	+10	-5	+6	+9	+5

CHARACTER OF DAY.				PRECIPITATION.	
Normal.	Clear 33.1.	Pt. Cloudy 36.4	Cloudy 30.4	None 45.8.	+ .or in 54.2.
School.	33.5 — 1	35.8 + 9	31.6 — 6	56.1 + 1	43.9 — 1
Male Ass't.	34.7 + 5	38. + 5	27.3 — 9	52.1 + 11	47.9 — 11
Fem. Ass't.	34.2 + 3	40.2 + 10	25.6 — 12	57.1 + 26	42.9 — 20
Peniten.	35.1 + 6	36.1 — 1	28.8 — 5	54.5 + 21	44.5 — 19
Male Ins.	33.1 ± 0	37.3 + 3	29.6 — 2	54.3 + 12	45.3 — 18
Fem. Ins.	54.3 + 3	36.2 — 1	30. — 1	54.8 + 18	55.2 — 16
Death.	46.6 + 2	34. — 2	19.3 ± 0	58.4 + 2	41.6 — 2
Suicide.	42.5 + 3	34.5 — 1	22.9 — 4	61.3 + 9	36.9 — 14
School At.	— 6	— 8	— 10	— 8	— 10
Banks.	33.3 — 4	33.7 + 1	33. + 3	52.2 — 2	47.8 + 2

DENVER.

Norma.	Clear. 41.	Pt. cloudy. 43.5	Cloudy. 15.5
School.	+ 3	+ 6	— 22
Suicide.	+ 2	— 3	+ 10
Murder.	— 14	— 2	+ 3 3

TEMPERATURE.

NORMAL.	0 5 .1	5 10 .2	10 20 .8	15 20 21.1	20 25 3.1	25 30 35	30 35 40	35 40 45	40 45 50	45 50 55	50 55 60	55 60 65	60 65 70	65 70 75	70 75 80	75 80 85	80 85 90	85 90 95
School.	.7 +75	.2 ± 0	1.6 ± 0	1.9 -10	4.2 -2	7.8 -20	9.9 -6	6.6 -20	8.9 -7	12.1 +11	13.8 +24	7.5 +6	7.9 +20	9.5 -5	6. +2	2. -5	.16 -50	.17 -50
M. As't.	.1 ± 0	.1 -50	.7 -12	.8 -27	2.3 -25	4. -27	6.5 -10	6.6 -7	8.4 -16	7.3 +2	7.8 -12	7.2 -1	8.7 +7	10.9 +10	14.8 +24	9.3 +35	3.7 +68	.4 +33
F. As't.		.2 ± 0	.3 -63	1.2 ± 0	1.8 -42	3.2 -42	5.2 -28	6.4 -10	6.3 -37	5.9 -17	6.4 -28	6.7 -8	7.6 -6	11.7 +18	16.2 +36	10.4 +52	4.4 +100	.2 -33
Peniten.	.1 ± 0	.05 -30	.5 -36	1.3 +20	2.5 -19	6. +9	8.7 +20	8.4 +18	10.5 +5	6.5 -8	8.4 -6	7.5 +3	8.3 +2	9.4 -9	12. +1	7.6 +9	2.7 +23	.8 +160
M. Ins.		.12 -40	1.1 +37	1.2 +10	2.4 -22	5.9 +7	6.6 -4	8.2 -13	9.2 -8	7.4 +4	8.1 -10	7. -3	9.2 +13	10.6 +6	12.7 +7	7. +2	3.1 +40	.1 -66
F. Ins.			1.2 +50	.5 -50	3. -3	5.3 -4	7. -3	7.8 -3	9.3 -7	6.3 -11	8.5 -5	8.3 -14	9.4 +16	10.6 +7	11.3 +6	9. +30	3. +36	.2 -33
Death.	.1 ± 0	.2 ± 0	1.2 ± 0	1.7 -15	3.9 -2	4.2 +2	7.5 -1	10.8 +1	8.5 -1	6.2 -6	7.4 -7	7.4 -7	8.2 -9	11.8 -2	12. +14	8.6 +36	.9 +80	
Suicide.	.1 ± 0	.4 +33	1.4 +15	1.4 -30	3. -25	3.2 -21	6.5 -14	7.3 -31	7.9 +20	6.3 -5	7.6 -5	7.9 -1	8. -10	13.7 +14	14. +33	9.3 +45	.8 +60	
Sch. Att.	-15	-10	-10	-10	-5	-10	-10	-8	-9	-7	-7	-7	-10	-12	-10	-10	-14	-8
Banks.			1.1 -8	1.2 -20	2.5 -4	6.8 +4	9.5 ± 0	6.4 -11	6.6 -6	7.8 -3	10. -2	5.8 -20	9.1 +5	11.5 +5	13.3 +6	5.5 +4	2.3 +43	.16 +66

DENVER.

(Min.) Normal.	0 10 4	10 20 9.	20 30 23.	30 40 21.	40 50 16.	50 60 18	60 70 5.	70 80 1.5	80 90 .5	90 100
School		+100	+16	-20	+15	+16	+20	-60	-300	
Suicide		-50	+20	-16	-35	+20	+23	+28	+50	+75
Murder		-60	-50	-33	+15	-20	-21	+33	+38	+100

HUMIDITY.

	30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 .4	35 40 45 50 55 60 65 70 75 80 85 90 95 100 .4	40 45 50 55 60 65 70 75 80 85 90 95 100 .4	45 50 55 60 65 70 75 80 85 90 95 100 .4	50 55 60 65 70 75 80 85 90 95 100 .4	55 60 65 70 75 80 85 90 95 100 .4	60 65 70 75 80 85 90 95 100 .4	65 70 75 80 85 90 95 100 .4	70 75 80 85 90 95 100 .4	75 80 85 90 95 100 .4	80 85 90 95 100 .4	85 90 95 100 .4	90 95 100 .4	95 100 .4	100 .4	
Normal.																
School.																
M. Ass'tt.	.1	.1	.5	.2	.3	.5	.8	.11	.14	.17	.20	.23	.26	.29	.32	.35
F. Ass'tt.	.07	.1	.2	.3	.5	.8	.11	.14	.17	.20	.23	.26	.29	.32	.35	.38
Peniten.	.1	.1	.8	.2	.3	.5	.8	.11	.14	.17	.20	.23	.26	.29	.32	.35
M. Ins.			.6	.2	.3	.5	.8	.11	.14	.17	.20	.23	.26	.29	.32	.35
F. Ins.			.6	.2	.3	.5	.8	.11	.14	.17	.20	.23	.26	.29	.32	.35
Death.			.6	.2	.3	.5	.8	.11	.14	.17	.20	.23	.26	.29	.32	.35
Suicide.			.6	.2	.3	.5	.8	.11	.14	.17	.20	.23	.26	.29	.32	.35
Sch. Att			.6	.2	.3	.5	.8	.11	.14	.17	.20	.23	.26	.29	.32	.35
Banks.			.6	.2	.3	.5	.8	.11	.14	.17	.20	.23	.26	.29	.32	.35

DENVER.

(Min.) Normal.	10 20 30 40 50 60 70 80 90 100 3.	20 30 40 50 60 70 80 90 100 3.	30 40 50 60 70 80 90 100 3.	40 50 60 70 80 90 100 3.	50 60 70 80 90 100 3.	60 70 80 90 100 3.	70 80 90 100 3.	80 90 100 3.	90 100 3.
School.	+500	+700	+50	+11	+10	+15	+16	+16	+33
Suicide.	+40	+800	+110	+90	+12	+18	+39	+7	+40
Murder.	+400	+300	+125	+100	+14	+33	+20	+46	+9

WIND.

	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750
Norm.		.9	10.5	19.2	21.8	15.2	10.9	7.7	5.8	2.6	1.6	1.3	.5	.4	.2	.2
School.		.1	4.6	10.8	16.8	16.6	13.2	10.3	9	5.2	4.2	1.5	1.1	.9	.5	.5
M. As'tt.		-.50	-18	-2	-3	-2	-2	+4	+3	+13	-2	-21	-18	± 0	-28	± 0
F. As'tt.		.8	10.8	21.3	22.6	15.6	10.3	7.3	5.3	2.5	1.5	1.2	.5	.4	.15	.15
Pen.		.4	12.1	21.7	24.6	14.1	10.	6.2	5.5	2.3	1.1	.7	.5	.2	.12	.12
M. Ins.		.7	10.6	19.9	22.1	15.1	10.8	7.5	6.5	3.6	1.6	1.3	.3	.3	.2	.2
F. Ins.		.6	10.6	20	22.3	14.5	11.7	8.3	5.3	2.9	1.3	1.1	.5	.5	.2	.2
Death.		.3	10.8	19.5	21.7	15.1	10.7	8.6	7.3	2.	1.6	1.2	.6	.5	.5	.5
Suicide.		.10.9	24.4	22.2	17.7	7.9	5.9	4.	2.8	1.5	1.5	.3	.6	.3	.5	.5
Sch. Att.		+4	+2	+2	-4	+1	-6	+5	-4	± 0	-6	± 0	+20	± 0	+25	± 0
Banks.		+12.6	22.9	25.9	13.3	7.3	5.3	5.3	3.3	1.1	.1	.3	.3	.5	.4	.4
		-20	-4	+18	-18	-6	-16	+39	-14	-27	-38	± 0	-40	+66	± 0	± 0
		-29	-9	-9	-9	-9	-8	-9	-6	-8	-8	-8	-13	-8	-15	-15
		.3	3.4	13.	16.3	18.3	15.2	10.5	7.4	4.2	2.6	1.9	2.4	.6	.6	.6
		± 0	+3	+8	+3	± 0	-2	-3	-3	-8	-28	-10	-8	-40	± 0	± 0

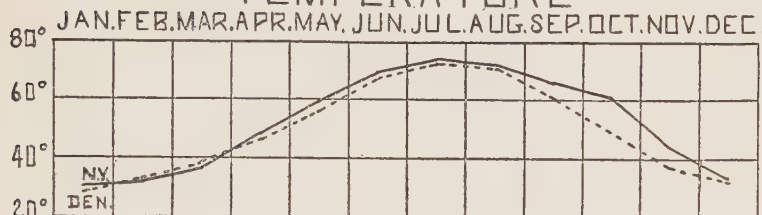
DENVER.

	50	100	150	200	250	300	350	400
Normal.	6.5	48.5	29.	11.	2.5	.8	.3	.3
School.	-66	-4	+6	+10	+28	+200	+450	+450
Suicide.	-85	-25	+25	+21	+250	+300	+400	+400
Murder.	-55	-15	± 0	± 0	+240	+400	+400	+400

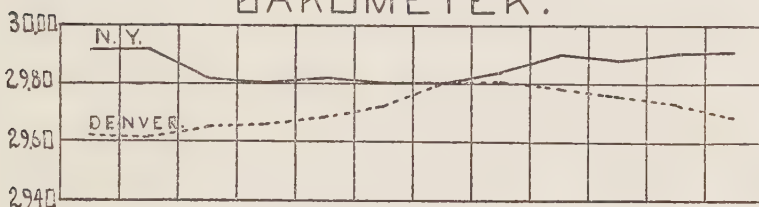
DESCRIPTION OF FIGURES.

In the figures the meteorological conditions are indicated at the top, and in any column the readings are for the condition at its head. Percentages of *excess* or *deficiency* are read in horizontal distances from the base line to which each curve is referred. Distances above the base line indicate *excess*; below, *deficiency* in the occurrence of data with which the curve deals. The lighter, horizontal lines show differences of 20%. In the curves for Denver, on the Temperature, Barometer and Humidity charts, meteorological groups are used, equal to two of those given at the top. For that city, too, five inches must be subtracted from the readings on the Barometer chart. For a fuller description of the curves see page 12.

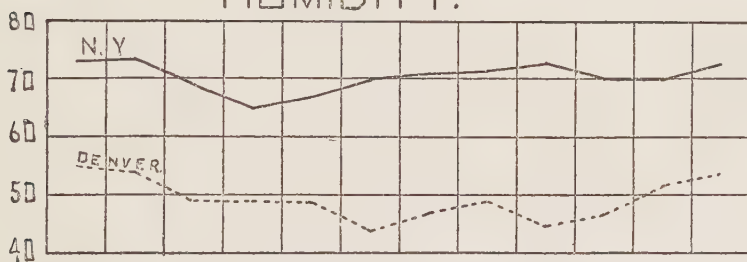
FIG. 8.
MONTHLY MEANS
TEMPERATURE



BAROMETER.



HUMIDITY.



WIND. TOTAL MOVEMENT.

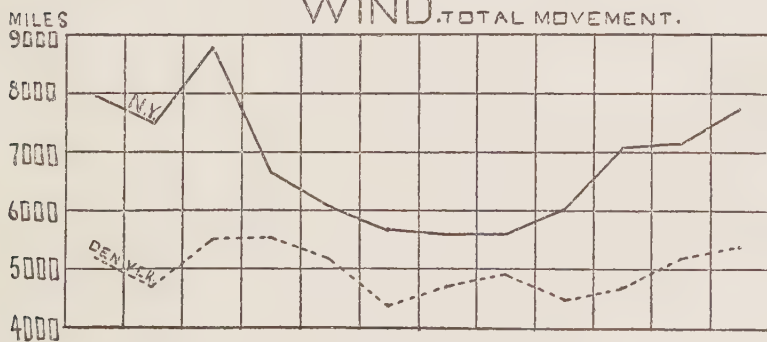


FIG. 9
JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.

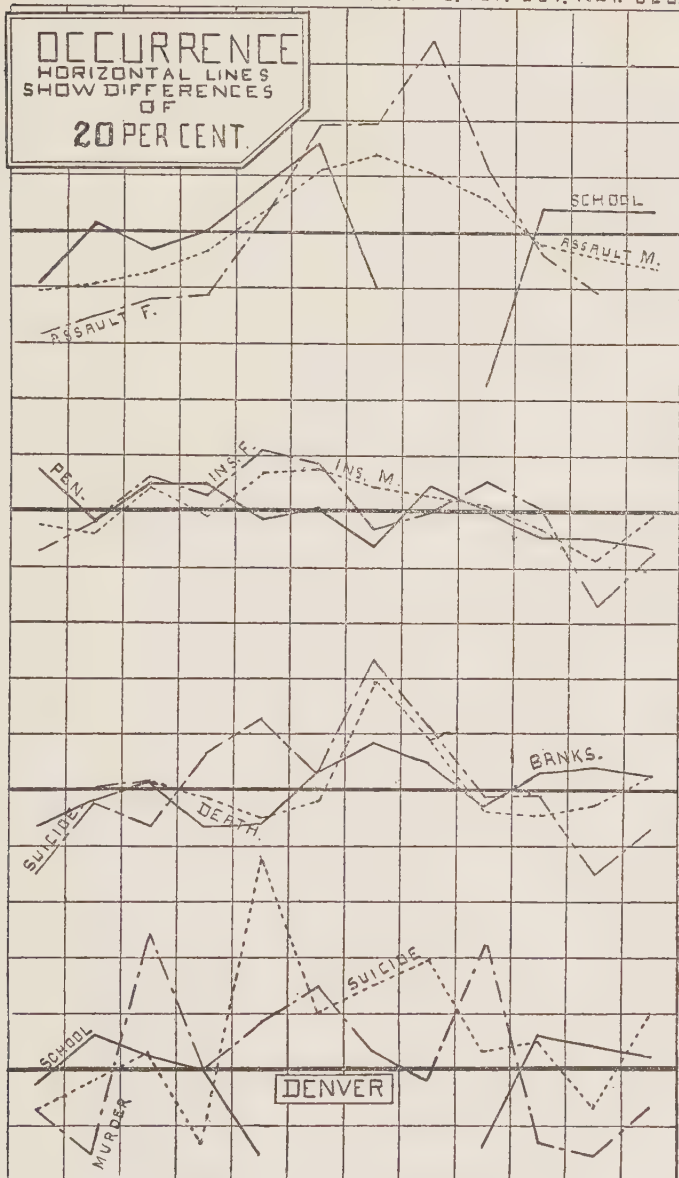


FIG. 10.

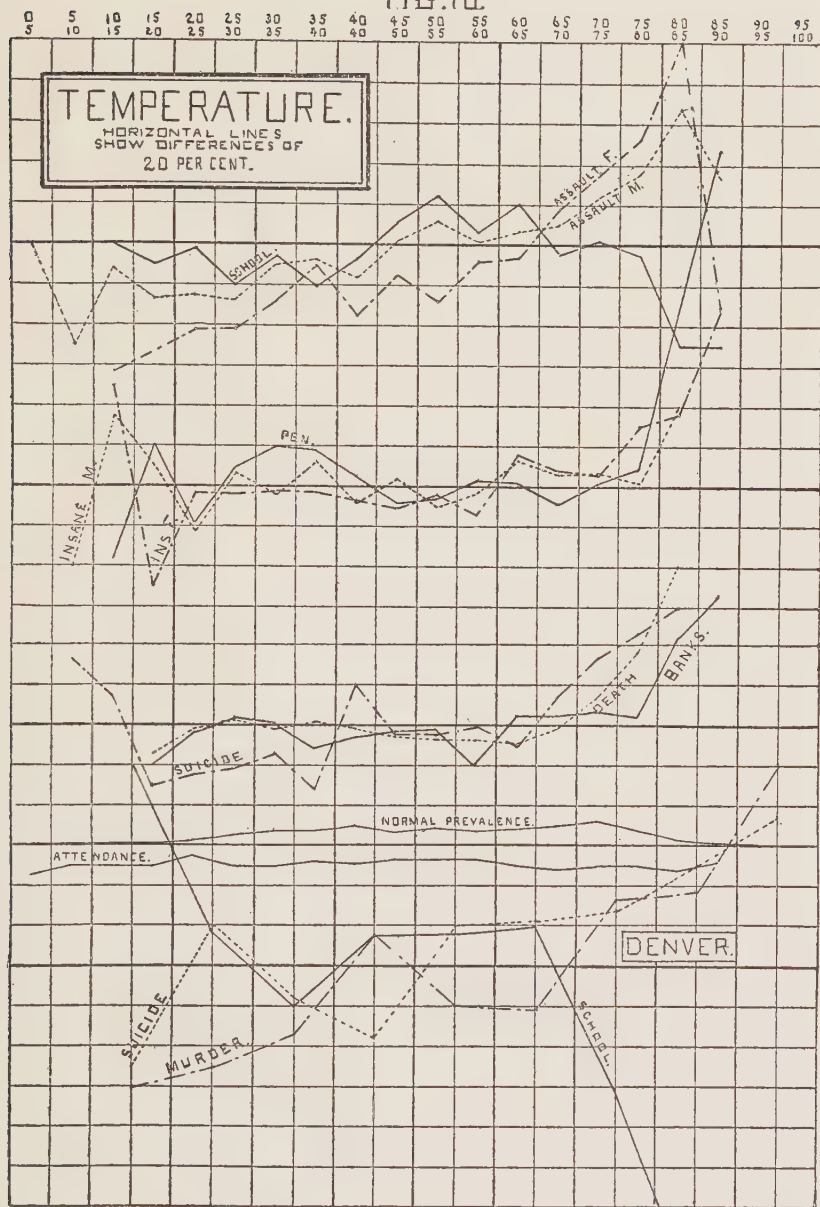


FIG II.

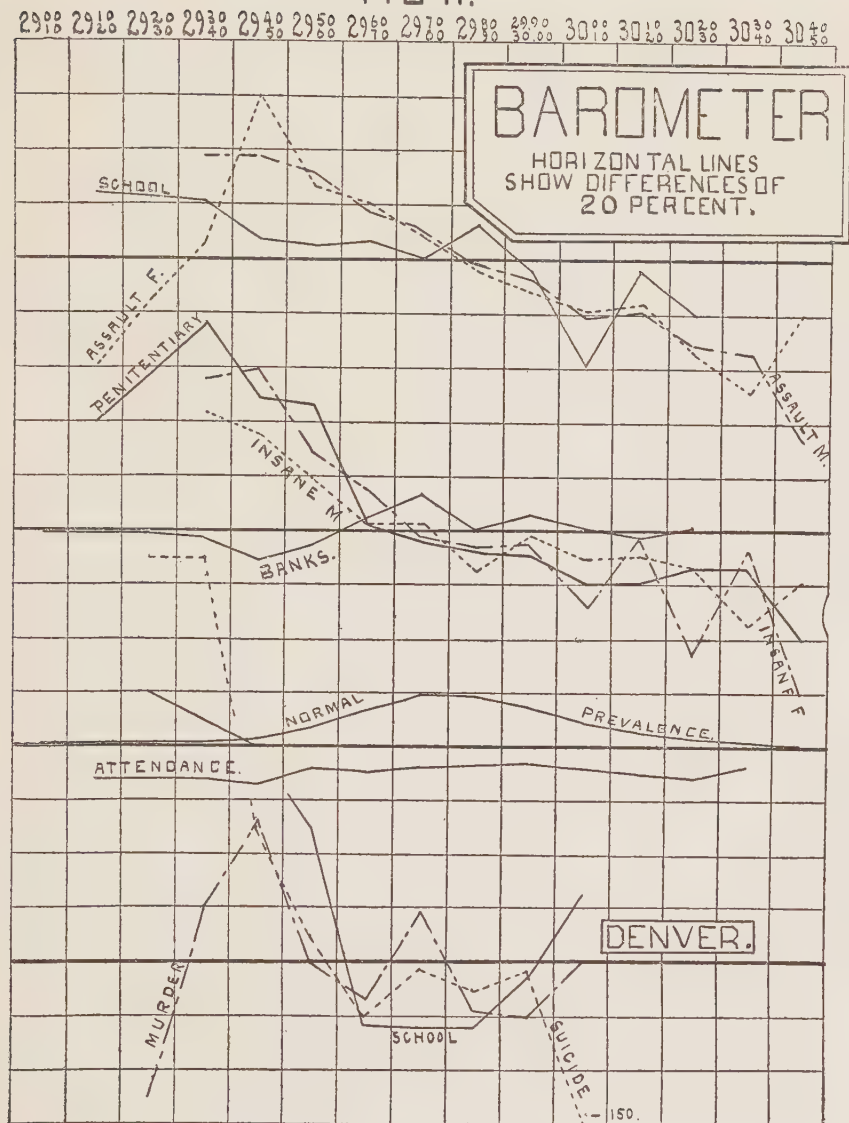


FIG. 12

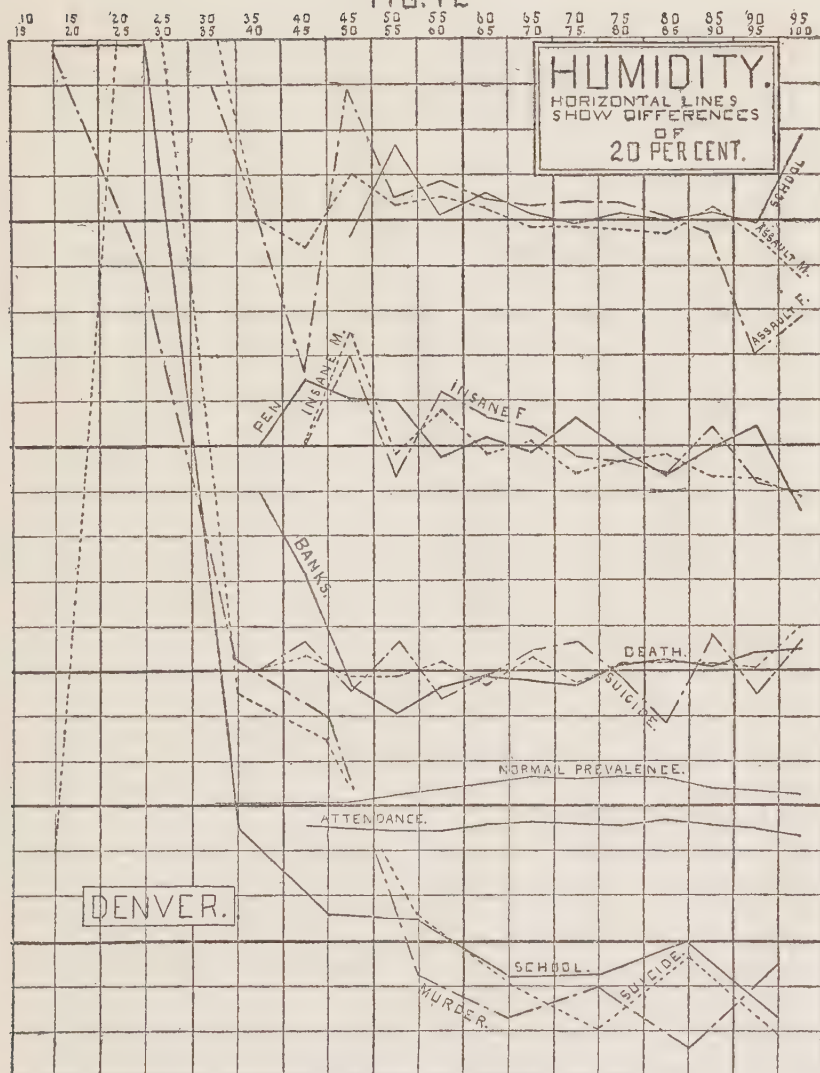


FIG. 13.

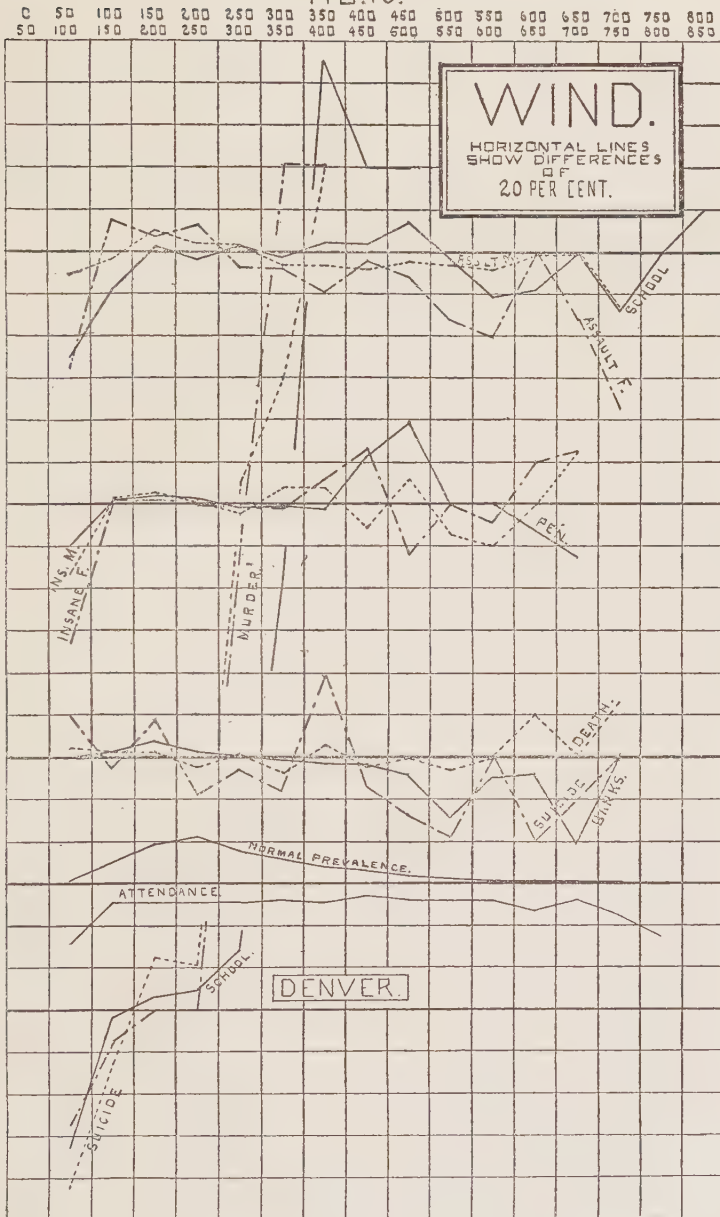
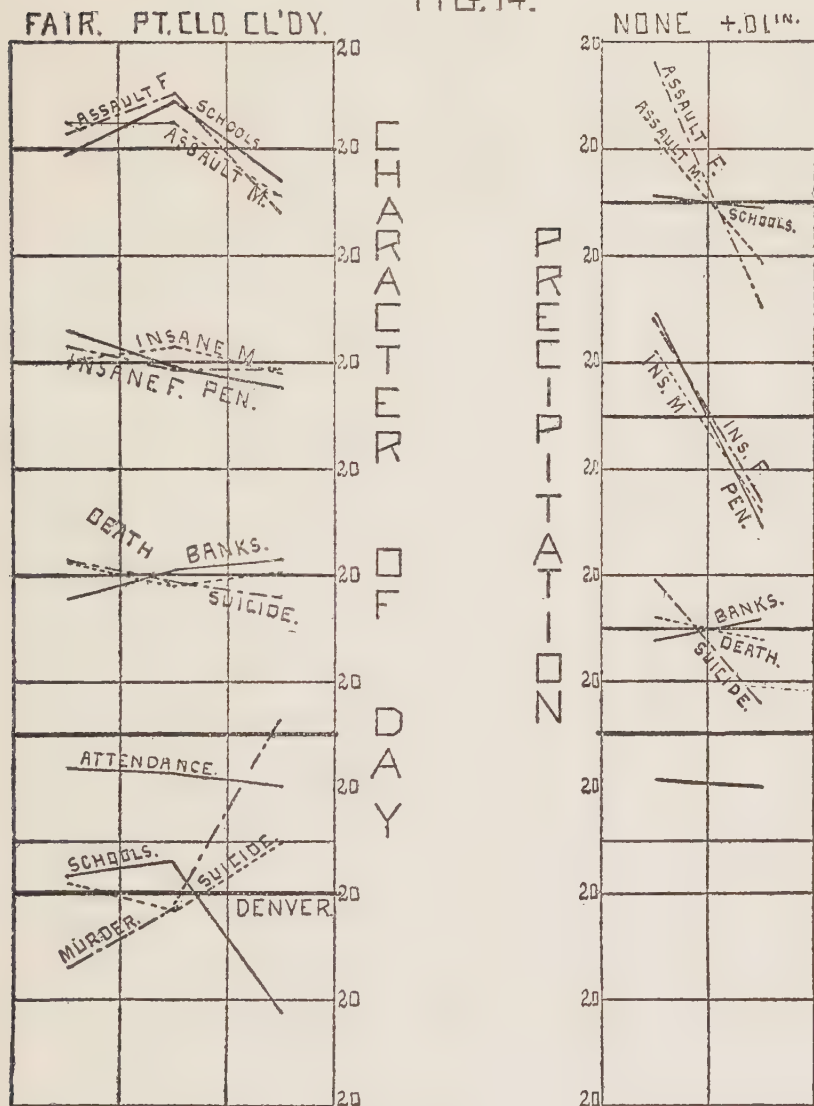


FIG. 14.



VITA.

The writer of this paper was born in Calais, Maine, July 21, 1868. His early education was had in the public schools of Templeton, Mass., completing his preparation for college at Worcester Academy, Worcester, Mass. He was graduated from Brown University in the class of 1891, with the degree of Bachelor of Philosophy. The following year he spent as instructor in the same university, receiving the Master's degree *summa cum laude* in June, 1892. The three school years, 1892-1895, he spent as Science Master of the Colorado Springs High School, Colorado Springs, Colorado. The summers included in that period he was Director of the Colorado Summer School of Science, Philosophy and Language. In June, 1895, he was appointed Instructor in Psychology in the Colorado State Normal School at Greeley, Colo., and the following year Professor of the same subject, which position he still holds. For the college year 1898-99 he held a Fellowship in the Teachers College, Columbia University, taking as his major subject Education, and as minors, Psychology and Philosophy.

COLUMBIA UNIVERSITY, April, 1899.

